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ARMY MOBILITY ENERGY RESEARCH & DEVELOPMENT PLAN.(U)
1980

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1st edition

ARMY MOBILITY ENERGY RESEARCH & DEVELOPMENT PLAN, 1980

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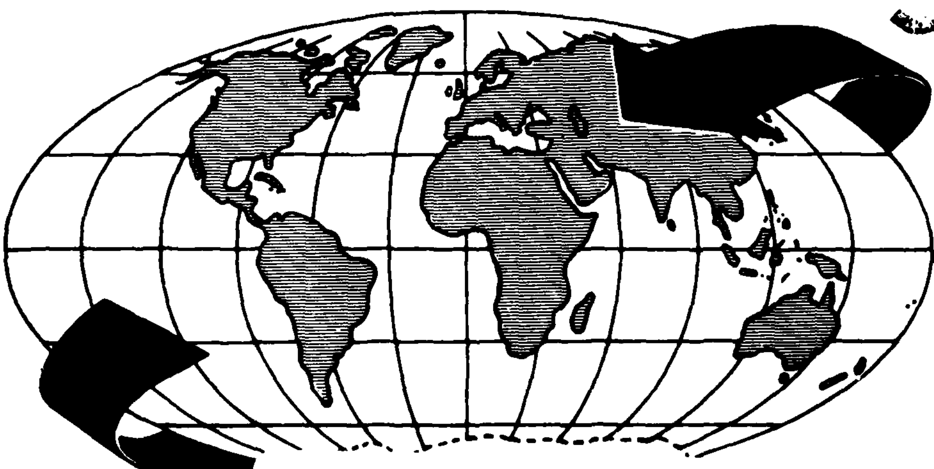

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DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF
FOR RESEARCH, DEVELOPMENT, AND ACQUISITION
WASHINGTON, D.C. 20310

REPLY TO ATTENTION OF DAMA-ARZ-E

15 JUL 1980

SUBJECT: Army Energy R&D Plan (Army Mobility Energy R&D Portion)

SEE DISTRIBUTION

1. Reference:

   a. AR 11-27, 20 July 1976.

   b. Letter, DAMA-PPM-P, 8 May 1978, subject: Mobility Operations Energy Research and Development.

   c. DARCOM Energy R&D Seminar/Energy R&D Plan, 6 June 1979.

   d. Letter, DRDMA-G, 27 March 1980, subject: Army Energy R&D Plan (Army Mobility Energy R&D Portion).

2. Reference 1a is the Army Regulation concerning Energy Programs. Reference 1b is the tasking letter for preparation of the Army Mobility Energy R&D Plan. Reference 1c was the conference of all DARCOM R&D Commands soliciting input for the Army Mobility Energy Plan. Reference 1d transmitted an advance copy of the first edition of the Army Mobility Energy R&D Plan.

3. Inclosed is a finalized copy of the first edition of the Army Mobility Energy Plan (Incl 1).

4. The plan describes a management structure and recommends thrust areas for attainment of the Army Energy goals. The major thrusts of the plan are: (a) R&D effort to increase engine efficiency for rotary-winged aircraft, ground vehicles and mobile generators; (b) test and evaluation to allow use of alternate/synthetic fuels; and (c) the development and evaluation of lubricants, material, and dispensing systems compatible with the emerging fuel/engine systems. The management plan recommends using existing Army Program structure to respond to the new challenges of energy conservation and self-sufficiency. At a later date, the plan will include a facilities/installation section which is the responsibility of the Army Corps of Engineers. Effective planning and execution of these efforts are critical to the Army's contribution to the National Energy Program.

5. MERADCOM is designated as the lead organization for maintaining the plan, accomplishing general coordination outside DA, and conducting the recommended energy assessment function. Inquiries should be addressed to the Commander, US Army Mobility Equipment Research and Development Command, ATTN: DRDME-GL, Fort Belvoir, VA 22060.

6. In order to keep the plan current and viable, MERADCOM soon will request input, based on the results of the ongoing DARCOM review, and will update the plan. They will need results of programs underway and they will incorporate first results of their assessment activities.

7. Points of contact are:

DARCOM - Dr. Roland Gonano and Mr. Jim Bender
ATTN: DRCLDC
5001 Eisenhower Ave.
Alexandria, VA 22333
AV 284-9561/9562 COMM 274-9561/9562

MERADCOM - Primary: Mr. Maryland Kemp
Alternate: Mr. John Christians and Mr. M. E. LePera
ATTN: DRDME-GL
Fort Belvoir, VA 22060
AV 354-4594/5171 COMM 664-4594/5171

1 Incl
as

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FACILITIES ENERGY R&D (Not Supplied)

Use MERADCOM

LIST OF FIGURES

US ARMY MOBILITY ENERGY R&D PLAN

EXECUTIVE SUMMARY

Energy is necessary to the Army in maintaining readiness to assure national security in peace-time, crisis, or war. The Army energy program, which is in concert with and support of national energy goals, establishes the basis for reducing energy consumption, reducing dependency on conventional hydrocarbon fuels, and tasks the Army to obtain a position of energy leadership.

The overall objective of the Army Mobility Energy R&D Plan is to ensure a cohesive, coordinated program leading toward a stronger Mobility Energy R&D that can respond to existing and future Army requirements to cope with the coordinated R&D energy programs and provide documentation for R&D resource allocation.

National security objectives can be achieved only if we are prepared to meet essential military energy requirements. The ability of the US to deter armed conflict, to respond to military agression, to field modern and effective weapons, to meet our worldwide commitments, even to exist as a nation depends upon the availability of an adequate supply of energy of the type and quality necessary to meet the needs of our armed forces. At the same time, the military must also be aware and account for the needs of the economy.

The Army Mobility Energy R&D Plan, if implemented, should greatly assist the Army in supplying energy of the type, quality, and quantity for both short- and long-range time frames. The plan concentrates on energy systems (structure, power sources, equipment) which make more efficient use of fuels, reduce dependence on non-domestic fuels, and use less expensive and/or more plentiful (renewable) resources. The plan also provides a means for timely

assessment of R&D effort towards Army energy goals and objectives which include:

a. Reduce energy consumption by 35 percent by the year 2000. Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

b. Reduce dependence on non-renewable and scarce fuels by the year 2000.

(1) Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels.

(2) Increase efficiency on non-renewable energy dependent mobility systems by 15 percent with no degradation to readiness.

c. Attain a position of leadership in the pursuit of national energy goals.

In FY77 the Army consumed about 765 million gallons of petroleum: 58 percent was for heating oil; the remaining 42 percent was divided among jet fuel, diesel fuel, and motor gasoline. <u>The mobility consumption portion of the Army's petroleum usage is 45 percent</u>.[1] The mobility portion is allocated as shown in Figure ES-1.

The framework for Mobility Energy R&D established for the plan is shown in Figure ES-2. The four program areas shown are structured to allow inclusion of any type of project.

The technical performance plan, based on the four program areas shown in Figure ES-2, is shown in Figure ES-3. Besides the normal R&D and T&E phases,

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[1] In terms of total energy consumed, mobility operations account for only 16 percent.

FY77 MOBILITY FUEL CONSUMPTION

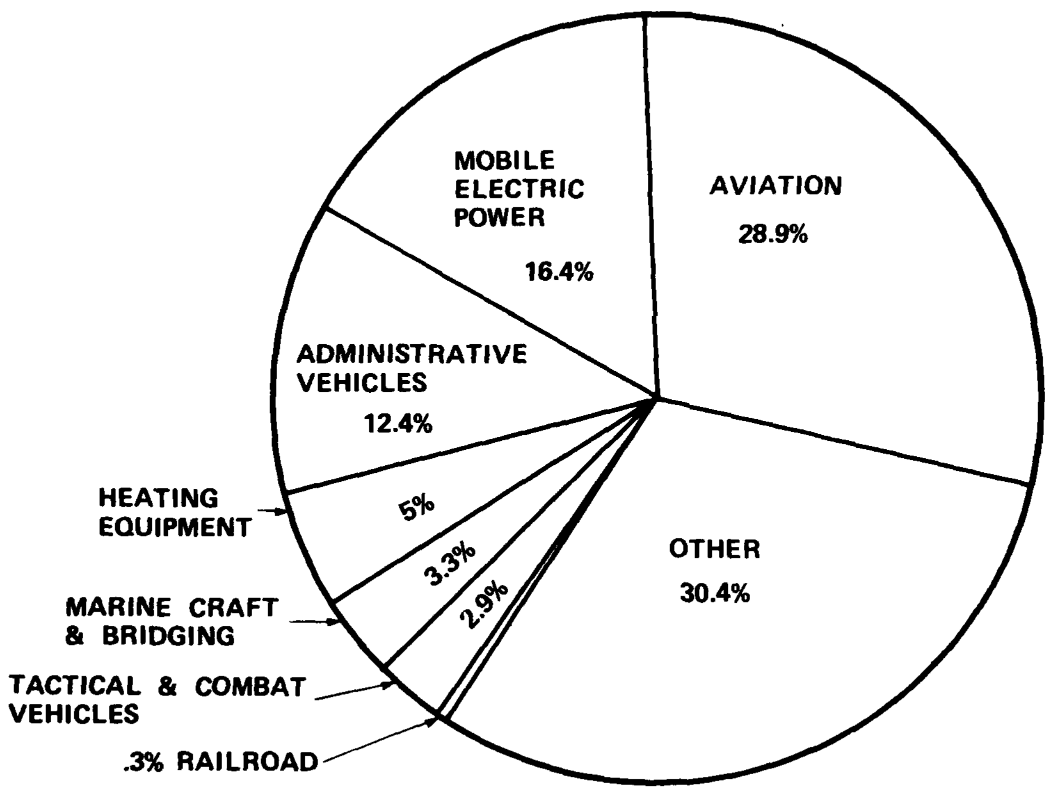


Figure ES-1

FRAMEWORK FOR ARMY MOBILITY ENERGY R&D PROGRAM

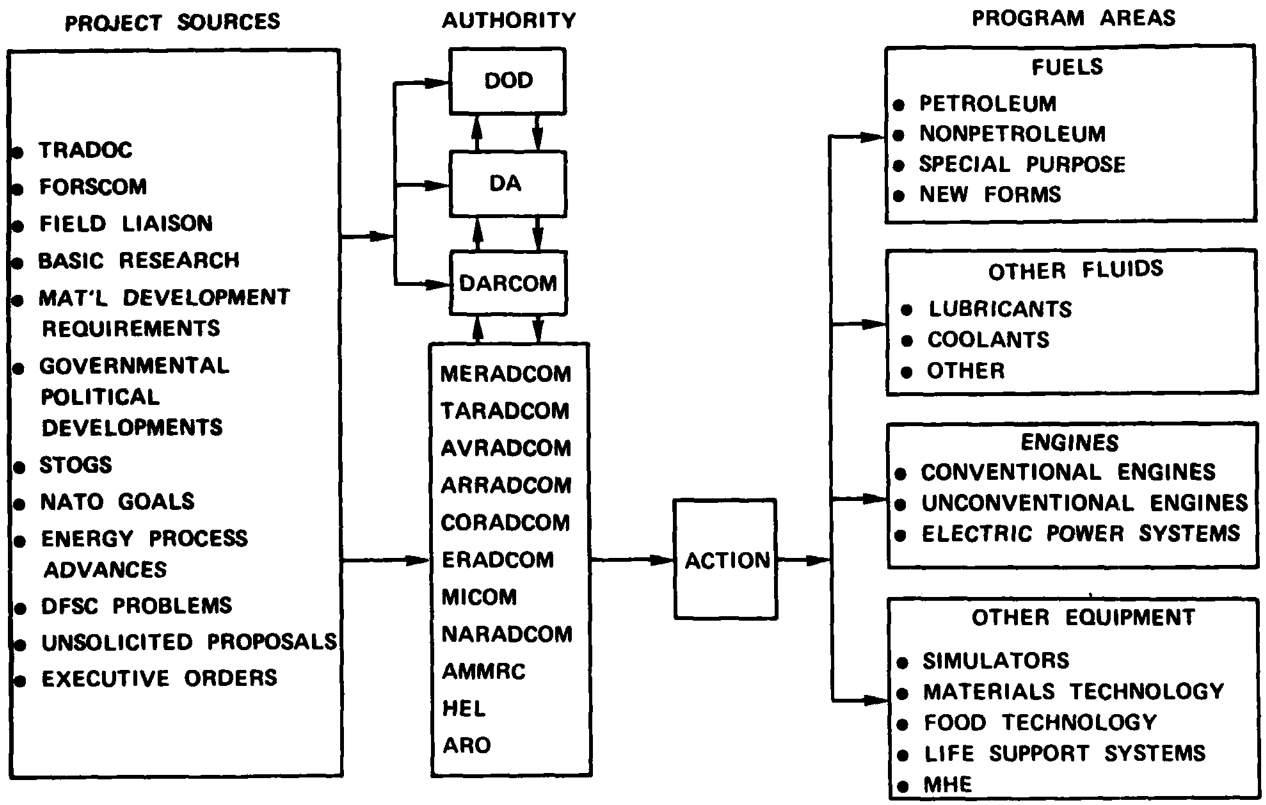
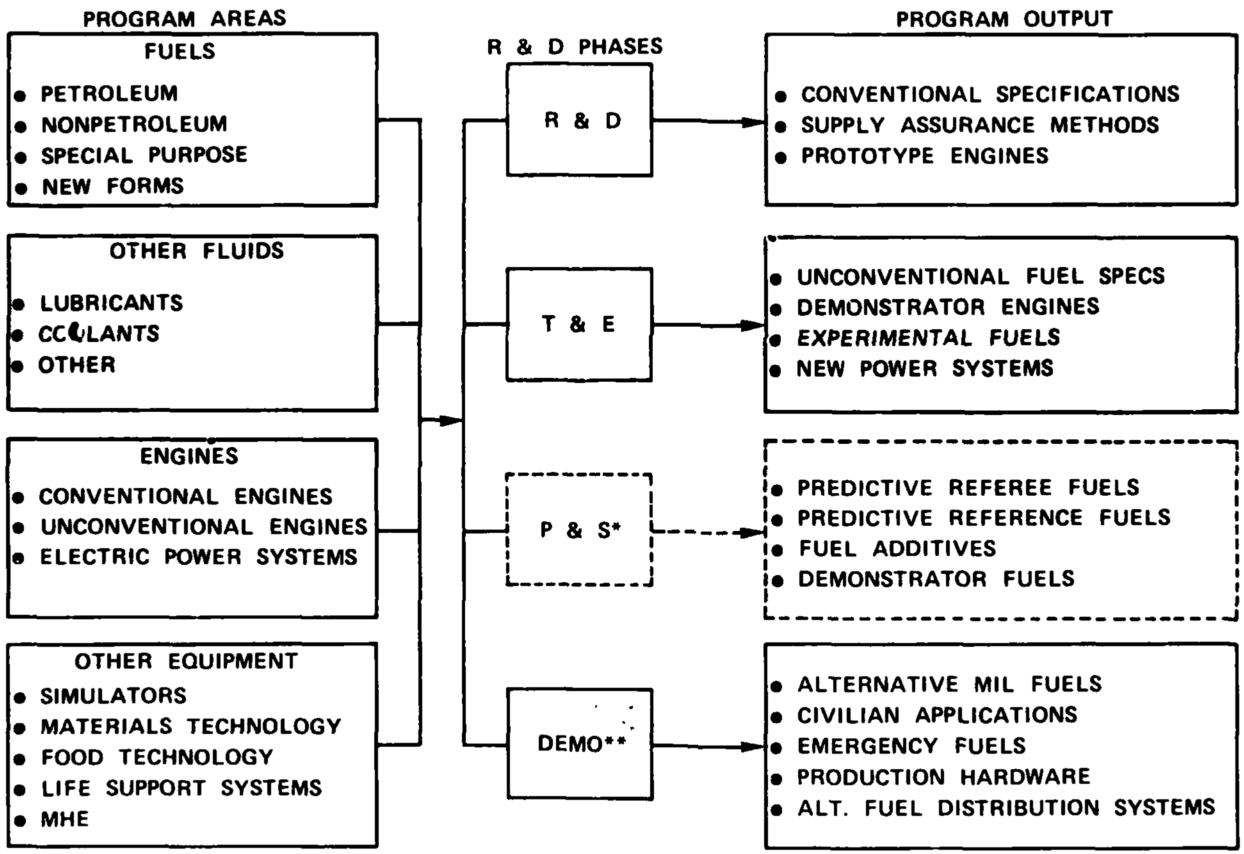


Figure ES-2

PERFORMANCE PLAN FOR ARMY MOBILITY R&D PROGRAM



* PRODUCTION AND STANDARDIZATION
** DEMONSTRATION

Figure ES-3

a Production and Standardization (P&S) and Demonstration phase have been included. The Production and Standardization phase is important for the fuels portion; and the Demonstration phase is included to identify existing and future cooperative efforts between DOE and DOD (DA) such as the solar photovoltaic DOD demonstration program.

The technical performance plan interaction and coordination effort is shown in Figure ES-4. An important feature shown on this figure is the assessment activity. The assessment activity includes development of a methodology to allow a quantified assessment of funded and unfunded programs/projects, establishing a workable data base, conducting a needs analysis, determining gaps and voids, and making recommendations of new or modified efforts.

The management of the Army Mobility Energy R&D requires no change at the DA or DARCOM level, and can be executed through existing programs/projects. However, during the yearly DA/DARCOM RDT&E reviews, energy projects should be highlighted.

The Mobility Equipment R&D Command (MERADCOM) will update the plan, do general nature coordination, develop the assessment methodology, do needs analysis, develop necessary data base, and make appropriate program recommendations.

Three major programs were identified as particularly relevant to the Army energy goals and objectives: Alternative Fuels, Fuels and Lubricants, and Engine Development.

The FY80, FY81, and FY82 programs for the shale oil derived portion of the alternative fuel program are shown in Figures ES-5, ES-6, and ES-7. The funds shown are as of 8 February 1980. The other major effort in the Alternative

ARMY MOBILITY ENERGY R&D PROGRAM TECHNICAL PERFORMANCE PLAN INTERACTION

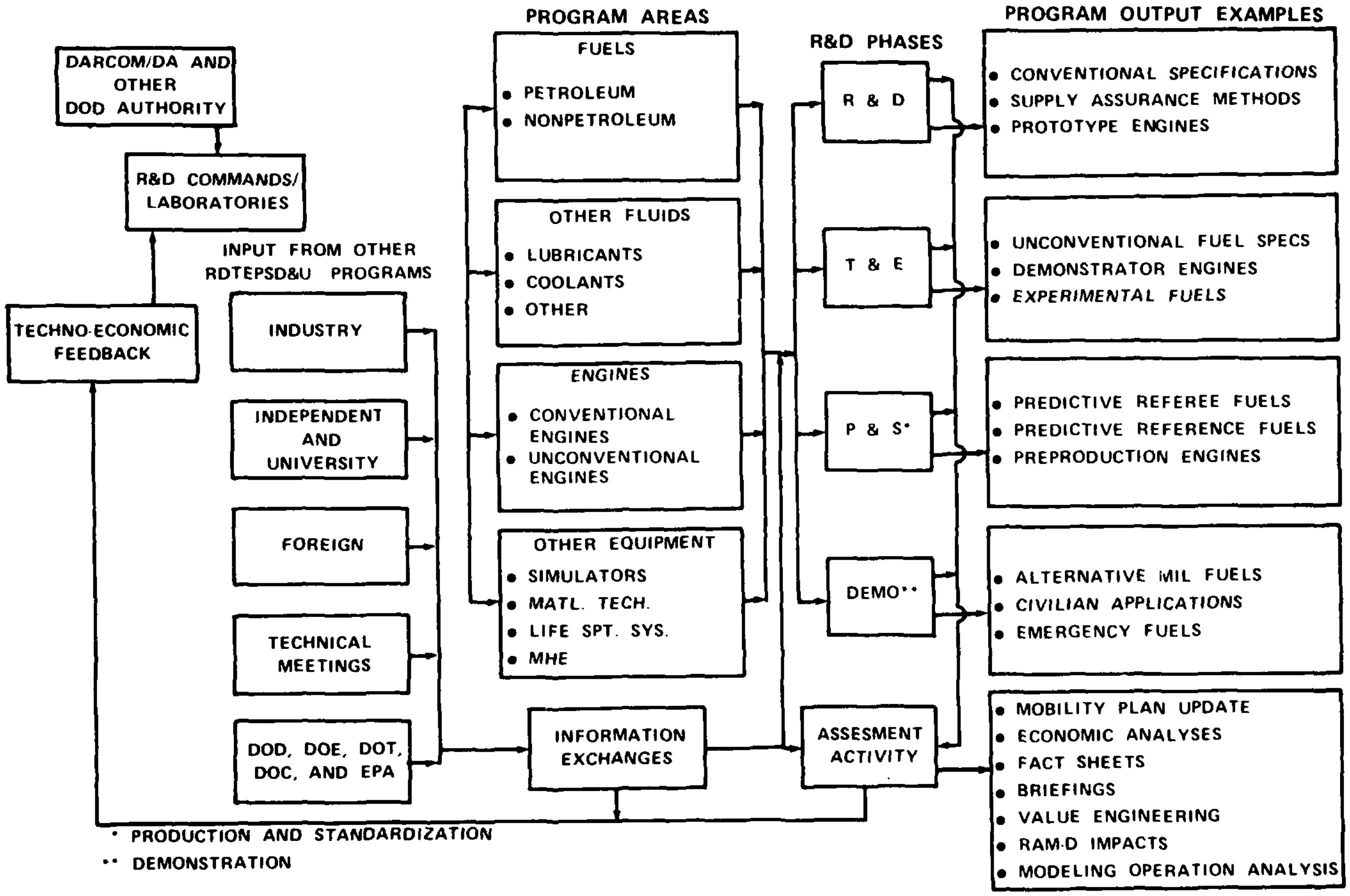


Figure ES-4

FY80 PROGRAM FOR ALTERNATIVE SYNFUELS-SHALE FUEL RDTE 8 FEB 80

TASK	AMOUNT $K*	TYPE	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	690	6.2	AFLRL	CONTRACT MOD
FUEL MATRIX STUDY	75	6.2	CONTRACTOR	
COMPATIBILITY:				
MATERIALS	100	6.2	MAT'L TECH LAB	TRANSFER
COMPONENTS, FHE	175	6.2	E&WR LAB	(DRDME-GS)
TOXICITY	150	6.2	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	350	6.2	ELEC PWR LAB	TRANSFER
VEHICLES	300	6.2	TARADCOM/TARCOM	MIPR
AIRCRAFT	100/(3600)	6.2/(6.4)	AVRADCOM	MIPR
LIAISON/COORDINATION	135	6.2	E&WR LAB	
SYSTEMS ANALYSIS	75	6.2	CONTRACTOR	
ACCELERATING QUAL				
METHODOLOGIES	89/(1000)	6.2/(6.3A)	CONTRACTOR	
TOTAL	2,239	6.2		
	(1,000)	(6.3A)		

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THROUGH DOD-DOE MOU. VALUES IN PARENTHESIS ARE UNFUNDED.

Figure ES-5. FY80 Program Alternative Synthetic Fuels Shale Synfuel Effort

PROGRAM FOR ALTERNATIVE SYNFUELS - SHALE FUEL RDTE

TASK	AMOUNT $K*	TYPE	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	365	6.2	AFLRL	
COMPATIBILITY:				
MATERIALS	125	6.2	IN-HOUSE	
COMPONENTS, FHE	150	6.2	IN-HOUSE	
TOXICITY	200	6.2	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	250	6.2	IN-HOUSE	
VEHICLES	400	6.2	TARADCOM/TARCOM	MIPR
AIRCRAFT	(8000)	(6.4)		
LIAISON/COORDINATION	125	6.2	IN-HOUSE	
ENGINEERING PILOT FIELD TESTS	350	6.2	IN-HOUSE/MIPR	
SYSTEMS ANALYSIS	100	6.2	CONTRACTOR	
ACCELERATING QUAL METHODOLOGIES	100/(1158)	6.2/(6.3A)	CONTRACTOR	
TOTAL	2165	6.2		

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THROUGH DOD-DOE MOU. VALUES SHOWN IN PARENTHESIS ARE UNFUNDED.

Figure ES-6. FY81 Program Alternate Synthetic Fuels Shale Synfuel Effort

FY82 PROGRAM FOR ALTERNATIVE SYNFUELS - SHALE & COAL FUELS RDTE 8 FEB 80

TASK	AMOUNT $K * (SHALE)	(COAL)	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	200	600	AFLRL	
COMPATIBILITY:				
MATERIALS	100	175	IN-HOUSE	
COMPONENTS, FHE	150	250	IN-HOUSE	
TOXICITY	100	250	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	250	350	IN-HOUSE	
VEHICLES	350	250	TARADCOM/TARCOM	MIPR
AIRCRAFT	0(6600)	125	AVRADCOM	MIPR
LIAISON/COORDINATION	150	145	IN-HOUSE	
ENGR PILOT FIELD TEST	350	--	IN-HOUSE/MIPR	
SYSTEMS ANALYSIS	150	125	CONTRACTOR	
ACCELERATING QUAL	300	200	CONTRACTOR	
METHODOLOGIES				
	2100	2470		
TOTAL	4570			

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THRU DOD-DOE MOU. VALUES SHOWN IN PARENTHESIS ARE UNFUNDED.

Figure ES-7. Program Alternate Synthetic Fuels Shale Synfuel Effort

Fuels Program, Gasohol Evaluation, is shown in Figures ES-8 and ES-9. The funds shown are as of 8 February 1980.

The funding profiles for recommended Army Engine Development are shown in Figure ES-10 with both funded and unfunded displayed. The funds shown in the figure are as of 27 November 1979. It became obvious in developing an Army engine program that the DA policy accepted from the "Wheels Study" for vehicle engines needs to be reexamined in light of the recent developments in energy, particularly petroleum energy; and the emphasis on conservation, efficiency, and use of alternative fuels. The basic thrusts of the engine program should encompass:

a. R&D to develop multifuel engines and engines capable of operating on multisource fuels;

b. R&D to develop engines that use other than conventional liquid fuels;

c. Improving efficiency of existing engines through new engine component developments and economic retrofit.

Other efforts that are proposed for consideration and planning during FY80 are:

d. Contingency planning for the transition from petroleum to synthetic fuels;

e. Increasing the use of simulator in training (designed for maximum energy efficiency);

f. Modification or selection of automotive engine lubricating oils and other fluids for use with alternative fuels and for conservation.

The process of developing the Army Mobility Energy R&D Plan included requesting and receiving from all DARCOM R&D Commands, recommendations for energy/energy related projects. Seventy-nine (79) inputs were received.

PLANNED OBLIGATION OF INCREASED FUNDS FOR GASOHOL PROGRAM

TASK	AMOUNT $K	ACTIVITY	ACTION REQUIRED
COMPATIBILITY:			
MATERIALS	100	MAT'L TECH LAB	TRANSFER
COMPONENTS, FHE	45	E&WR LAB	(DRDME-GS)
COORDINATION & LIAISON	70	E&WR LAB	(DRDME-GL)
ENGINE ENDURANCE TESTING:			
GROUND SPT EQUIP	350	ELEC PWR LAB	TRANSFER
VEHICLES	100	AFLRL	CONTRACT MOD
FLEET TESTING[1]			
FORT BELVOIR	75	--------	MIPR
RED RIVER ARMY DEPOT	75	--------	MIPR
LETTERKENNY ARMY DEPOT	75	--------	MIPR
FORT LEWIS	75	--------	MIPR
TOTAL	965		

[1] FUNDING PROVIDES FOR ESTABLISHING BASE PROGRAM MONITOR AND PROCUREMENT OF ALCOHOL

Figure ES-8. FY80 Program - Gasohol Evaluation

FY81 PROGRAM FOR GASOHOL EVALUATION

TASK	AMOUNT $K[1]	ACTIVITY	ACTION REQUIRED
COMPATIBILITY:			
MATERIALS	100	MAT'L TECH LAB	TRANSFER
COMPONENTS' FHE	75	E&WR LAB	(DRDME-GS)
COORDINATION & LIAISON	75	E&WR LAB	(DRDME-GL)
ENGINE ENDURANCE TESTING:			
GROUND SPT EQUIP	100	ELEC PWR LAB	TRANSFER
VEHICLES	--0--		
FLEET TESTING[2]			
FORT BELVOIR	220	--------	MIPR
RED RIVER ARMY DEPOT	220	--------	MIPR
LETTERKENNY ARMY DEPOT	220	--------	MIPR
FORT LEWIS	220	--------	MIPR
TOTAL	1230		

[1] VALUES SHOWN REFLECT REQUIRED LEVEL OF FUNDS. TO DATE, FY81 PROGRAM IS UNFUNDED.

[2] FUNDING PROVIDES FOR BASE PROGRAM MONITOR COORDINATION ACTIVITIES AND PROCUREMENT OF ALCOHOL/GASOHOL

Figure ES-9. FY81 Program - Gasohol Evaluation

They were subjectively assessed for "energy relevance" and assigned values as shown in Figure ES-11. They are summarized in Figures ES-12, ES-13, ES-14, ES-15, and ES-16, and are catalogued into the four program areas shown in Figure ES-2. They are further identified as funded or unfunded.

The overall assessment or findings on the Army Mobility Energy R&D efforts, as they exist today, are:

a. The Army needs a better coordination process, within the R&D community, at the DA level and outside DA.

b. The Army needs to actively support and seek funding, or continue funding, energy relevant programs, especially alternative fuels, fuels and lubricants, and engine development.

c. The Army needs to reconsider that portion of the "Wheels Study" that essentially prohibits engine development work.

d. The Army organization and project structure is adequate to accomplish the R&D.

e. A methodology for determining "Energy Relevance" assessment needs to be developed.

f. There is possibly limited funding for efforts towards petroleum conservation (reduce petroleum consumption by 10 percent by 1985). (See Tables 1 and 2.)

1400 K in FY80	(6.2 and 6.3a)
1915 K in FY81	(6.2 and 6.3a)
200 K in FY82	(6.2)

However, it also may be that in fact, Mobility Energy R&D may not positively contribute toward this goal, particularly if many of the major projects introduce hardware into the field; e.g., the XM-1 consumes fuel at a much higher rate than the M-60.

ARMY ENGINE/HARDWARE RDTE PROGRAMS

	FY80	FY81	FY82	FY83
MERADCOM				
FUNDED	1,780	1,713	630	1,040
UNFUNDED	700	1,500	1,500	2,500
AVRADCOM				
FUNDED	240	1,027	5,906	9,325
UNFUNDED	6,110	21,910	27,319	17,433
TARADCOM				
FUNDED	5,867	7,836	11,783	15,534
UNFUNDED	0	8,052	869	400

AS OF 27 APR 80

Figure ES-10. Army Engine/Hardware RDTE Programs

ASSESSMENT VALUE
(ENERGY RELEVANCE)

NOTE: MAKES NO JUDGMENT ON PROJECT TO MEET ARMY REQUIREMENTS; ONLY ITS CONTRIBUTION TO ARMY MOBILITY ENERGY R&D

VALUE (FOR MOBILITY ENERGY R&D)

5 – MUST PROGRAM, SHOULD BE FUNDED
EXCELLENT ENERGY SUPPORT

4 – HIGH POTENTIAL, SHOULD BE FUNDED
HIGH ENERGY SUPPORT

3 – GOOD, FUNDED IF MONIES EXIST
GOOD ENERGY SUPPORT

2 – MARGINAL, LIMITED SUPPORT TO ARMY ENERGY GOALS

1 – UNDECIDED, NEED TO EXAMINE IN FY80 TO DETERMINE IF IT SHOULD REMAIN IN ENERGY PLAN

0 – NOT ENERGY RELATED

MARK (FOR 6.1 PROJECTS)
+ 0 RELEVANT
– 0 NOT RELEVANT

Figure ES-11

FUELS-FUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
37	ENZYMATIC HYD. OF CELL. MATLS.	NAR	4	6.1	AH52	100	150	150
27	FUEL STABILITY AND TEST DEVELOPMENT	MER	4	6.2	AH20	100	75	100
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.2	AH20	300	2,165	430
29	HIGH ENERGY FUELS	MER	3	6.2	AH20	100	75	100
79	GASOHOL EVALUATION	MER	4	6.2	AH20	130	0	0
28	MILITARY FUEL MONITOR	MER	1	6.3	D150	0	0	100
29	HIGH ENERGY FUELS	MER	3	6.3	D150	0	0	200
25	USER ACCEPTANCE TESTING OF FUELS	MER	1	6.3	D150	0	0	350

OTHER FLUIDS-FUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
23	LONG LIFE COOLANT SYSTEM	MER	2	6.2	AH20	100	100	125
26	USE OF RECYCLED OILS	MER	2	6.2	AH20	100	90	50
23	LONG LIFE COOLANT SYSTEM	MER	2	6.3A	D150	0	0	200

Figure ES-12

ENGINES-FUNDED (AS OF 24 APR 80)

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
12	MACI ENGINE PROGRAM	TAR	1	MACI	4301	120	0	0
75	ENGINE COMBUSTION RESEARCH	ARC	1	6.1	BH57	1,119	1,343	1,612
2	ENGINE CONCEPTS FOR ALT. FUELS	TAR	5	6.2	N	0	900	1,000
18	VARIABLE CAPACITY ENGINE	AVR	3	6.2	AH76	190	190	245
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.2	AH76	50	0	0
21	ADVANCED HEAT ENGINES	MER	4	6.2	AH20	130	113	130
46	CERAMIC COMPONENT TECHNOLOGY	AMM	4	6.2	AH84	265	275	300
76	MULTI-FUEL ENGINES FOR TAC/COMB VEHICLES	TAR	5	6.2	AH91	0	900	1,000
8	ADV. TURBINE COMPONENTS	TAR	4	6.2	AH91	314	0	521
21	ADVANCED HEAT ENGINES	MER	4	6.3	DG11	1,650	1,600	500
4	AGT-1500 FUEL ECONOMY PROGRAM	TAR	3	6.3A	DG07	1,606	0	1,650
1	ADIABATIC DIESEL ENGINE	TAR	4	6.3A	N	566	0	6,531
10	ADV 1000 HP DIESEL ENGINE	TAR	3	6.3A	DG07	750	2,600	0
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.3A	D447	0	837	5,661
76	MULTI-FUEL ENGINES FOR TAC/COMB VEHICLES	TAR	5	6.3A	DG07	0	0	3,000
1	ADIABATIC DIESEL ENGINE	TAR	4	6.2	AH91	425	600	550

Figure ES-13

OTHER EQUIPMENT-FUNDED

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
47	HEAT ENGINE VEH. SYST. MATLS.	AMM	3	DOE	DOE	750	0	0
15	TRANSMISSIONS/TRANSFER ASSEM.	TAR	1	MACI	D607	282	0	0
14	ELECTRIC VEHICLE EVALUATION	TAR	4	MACI	4331	27	27	27
13	RADIAL VS BIAS PLY TIRES	TAR	2	MACI	6003	450	200	0
16	SIMPLIFIED TEST EQUIP. FOR I.C. ENGINES	TAR	2	PAA	D632	9,500	0	0
39	EFFICIENT MOBILE LAUNDRY EQUIP	NAR	0	PIP	0112	0	125	0
49	SUMARIUM-COBALT GEN. TECH.	HOL	3	6.1	N	100	0	0
19	FUEL CELL POWER PLANTS	MER	5	6.1	AH51	480	320	320
50	ELECTRONIC DEVICES RESEARCH	ERA	0	6.1	AH47	320	310	320
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.1	AH51	120	80	80
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.2	AH20	150	200	114
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.2	AH99	1,020	1,000	750
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.2	AH20	600	530	550
19	FUEL CELL POWER PLANTS	MER	5	6.2	AH20	300	220	270
40	REDUCTION OF FOOD WEIGHT/BULK	NAR	0	6.2	AH99	67	145	135
41	IMPROVEMENT IN FOOD PACKAGING	NAR	0	6.2	AH99	30	0	0
42	THERMOPROCESSED FIELD MEALS	NAR	0	6.2	AH99	200	160	146
43	AIRDROP SIMULATION	NAR	2	6.2	D283	120	200	200
44	COMPOSITE STRUCTURAL VEHICLE COMPS.	AMM	2	6.2	AH84	100	0	0
45	LIGHTWEIGHT SUSPENSION COMPS.	AMM	0	6.2	AH84	300	350	250
49	SUMARIUM-COBALT GEN. TECH.	HOL	3	6.2	N	165	100	0
51	POWER SOURCES FOR ELECT. DEVICES	ERA	0	6.2	AH94	739	650	880
3	ADV. COMPOSITE MATLS/STRUCTURES	TAR	2	6.2	AH91	342	325	275
19	FUEL CELL POWER PLANTS	MER	5	6.3	DG11	394	1,320	2,390
11	ADV. HYDROMECH. TRANSMISSION	TAR	3	6.3A	D395	1,639	2,110	1,906
30	CONTRASTING GROUND COVER	MER	0	6.3A	8201	100	150	150
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.3A	DG11	550	0	0
38	EFFICIENT FIELD OVEN/GRIDDLE	NAR	1	6.3A	DG10	83	120	0
49	SAMARIUM-COBALT GEN. TECH.	HDL	3	6.3A	N	0	250	0
52	ADV TACTICAL POWER SOURCES	ERA	0	6.3A	DG10	861	1,460	1,300
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.4	DL39	500	500	872
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.4	DL47	2,499	2,134	1,060

Figure ES-14. Other Equipment Funded (As of 1 May 80)

FUELS-UNFUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.1	AH51	0	0	315
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.2	AH20	0	0	6,125
29	HIGH ENERGY FUELS	MER	3	6.3	D150	0	150	0
79	GASOHOL EVALUATION	MER	4	6.3A	D150	1,065	1,230	100

OTHER FLUIDS-UNFUNDED (AS OF 15 AUG 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
32	NON-PETROLEUM BASED HYD. FLUIDS	MER	1	MACI	3582	150	200	200

ENGINES-UNFUNDED (AS OF 15 AUG 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
4	AGT-1500 FUEL ECONOMY PROGRAM	TAR	3	PIP	N	0	750	0
18	VARIABLE CAPACITY ENGINE	AVR	3	6.2	AH76	2,310	2,810	3,755
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.2	AH76	100	100	100
8	ADV. TURBINE COMPONENTS	TAR	4	6.2	AH91	0	422	0
78	ALTERNATE/MULTI-FUEL ENGINES FOR MEP	MER	4	6.2	AH20	700	1,500	1,500
10	ADV 1000 HP DIESEL ENGINE	TAR	3	6.3A	D607	0	380	0
1	ADIABATIC DIESEL ENGINE	TAR	4	6.3A	N	0	4,200	569
18	VARIABLE CAPACITY ENGINE	AVR	3	6.3A	N	0	11,000	15,000
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.3A	D447	100	0	1,864
77	MULTI-SOURCE FUEL ENGINES FOR AIRCRAFT	AVR	5	6.4	DG72	3,600	8,000	6,600

Figure ES-15

OTHER EQUIPMENT-UNFUNDED (AS OF 15 AUG 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
31	COMPARATIVE ANAL/MOB. CONST. EQUIP.	MER	3	MACI	5398	300	500	500
33	HYBRID FUEL CELLS	MER	3	MACI	3787	200	225	250
35	EFFICIENT ARMY WATERCRAFT	MER	2	PIP	N	0	0	500
39	EFFICIENT MOBIL LAUNDRY EQUIP	NAR	0	PIP	0112	215	0	0
19	FUEL CELL POWER PLANTS	MER	5	6.1	AH51	60	220	160
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.1	AH51	80	120	0
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.2	AH20	0	0	250
35	EFFICIENT ARMY WATERCRAFT	MER	2	6.2	AH20	200	300	0
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.2	AH99	1,323	1,473	1,410
48	FLUIDIC TEMPERATURE SENSOR	HDL	0	6.2	N	150	180	200
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.3A	DK39	0	0	1,425
38	EFFICIENT FIELD OVEN/GRIDDLE	NAR	1	6.3A	D610	32	5	0
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.4	DL47	81	246	1,310

Figure ES-16

Current funding for the Army goal of improving efficiency of (engines) mobility systems, 15 percent by the year 2000, is low now: (See Tables 1, 3, and 5)

7654 K in FY80	(6.1, 6.2, and 6.3a)
11790 K in FY81	(6.1, 6.2, and 6.3a)
9713 K in FY82	(6.1, 6.2, and 6.3a)

when compared to total requested funds:

12744 K in FY80	(funded and unfunded)
26820 K in FY81	(funded and unfunded)
32107 K in FY82	(funded and unfunded)

The funding for the Army goal of converting 10 percent of mobility operations to alternative/synthetic fuels by 2000 appears to be funded at about one-half of the total requested. The largest shortfall is for qualification of Army aircraft on alternative fuels (see Tables 1, 4, and 5).

TABLE ES-1. DA GOAL VS RDT&E CATEGORY

DA GOAL	6.1			6.2			6.3A			6.4			MACI			PIP			DOE			MMT		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
1a.																								
Funded				100	75	200	1300	1840					700	1000								210	1280	1008
Unfunded													300	500	500									
Increment								450																
2a. (1)																								
Funded	680	470	470	1045	4350	3150	394	3557	11251				27	27	27									
Unfunded	60	220	475	800	1600	7725	1165	4480	3964	3600	8000	6600	200	225	250									
Increment																								
2a. (2)																								
Funded	1289	1423	1692	1699	1730	1860	4716	8637	6161										750					
Unfunded	80	120		2910	3910	4105	3100	11000	18289							1000	1500							

TABLE ES-2. DA GOAL 1a. VS COMMAND

	MER			TAR		
	FY80	FY81	FY82	FY80	FY81	FY82
Unfunded						
6.1						
6.2	200	75	200			
6.3A				1637	2211	1906
Unfunded						
MACI	300	500	500			
Increment						
6.3A		150				

TABLE ES-3. DA GOAL 2a. (7) VS COMMAND

	AMM			AVR			MER			TAR			ARO		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Funded															
6.1							120	80	80				1119	1343	1612
6.2	265	275	300	240	190	245	880	843	794	378	600	1071			
6.3A					837	5661	2200	1600	500	2922	2600	8181			
6.4							500	500	872						
DOE	750														
Unfunded															
6.1							80	120							
6.2				2410	2910	3855			250	0	422				
6.3A				100	11000	16864			1425		4589				
6.4															
PIP										1000	1500				

TABLE ES-4. DA GOAL 2a. (1) VS COMMAND

	AVR			HDL			MER			NAR			TAR		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Funded															
6.1				100			480	320	320	100	150	150			
6.2	50			165	100		830	2450	1150					1800	2000
6.3A		837	5661		250		394	1320	2590						4000
MACI													27	27	27
Unfunded															
6.1							60	220	475						
6.2	100	100	100				700	1500	7625						
6.3A	100		1864				1065	1380	100					2300	
6.4	3600	8000	6600												
MACI							200	225	250						
Increment															
6.3A								300							

TABLE ES-5. TECHNICAL AREA VS RDT&E CATEGORY

	Funded			Unfunded			Increment		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Fuels									
6.1	100	150	150			315			
6.2	630	2315	630			6125			
6.3A			200	1065	1380	100		450	
Engines									
6.2	949	2800	3196	3610	5410	5355			
6.3A	4166	9787	9161	3100	11000	16864			
6.4				3600	8000	6600			
PIP				1000	1500				
Other Equipment									
6.1	700	400	400	140	340	160			
6.2	1215	1050	934			250			
6.3A	2244	3410	2390			1425			
6.4	500	500	872						
PIP									
MACI				500	725	750			

SECTION 1. INTRODUCTION

For a number of reasons (including the reliance on costly foreign crude oil), energy consumption has become a serious concern of the United States and its military services. Energy is necessary to the Army in maintaining readiness to assure national security in peace-time, crisis, or war. The Army energy program, which is in concert with and support of national energy goals, establishes the basis for reducing energy consumption and dependency on conventional hydrocarbon fuels; and tasks the Army to attain a position of energy leadership.[1]

Some of the goals require RDT&E, while others are directly attainable through operational decisions and actions. This plan addresses only the actions for RDT&E, but does summarize non-RDT&E efforts.

The energy RDT&E efforts to meet the goals fall into two categories: (1) mobility and (2) installations. Appendix A of this plan is the Army Mobility RDT&E Plan; Appendix B of this plan is the Army Facilities RDT&E Plan. The Mobility Equipment R&D Command (MERADCOM), a major subordinate command under the U.S. Army Development and Readiness Command (DARCOM) prepared section A - Mobility; the U.S. Army Construction Engineering Research Laboratory (CERL), a laboratory under the Office of Chief of Engineers (COE) prepared section B - Facilities.

The Army Energy RDT&E plan is within the context of the broader DOD energy plan and national energy goals. In this regard, DOD has established a set of general energy objectives combined with specific energy goals. The general objectives are intended to ensure that DOD energy policies and programs are directed towards meeting the overall energy related needs of DOD while the specific energy goals provide a means of measuring the progress towards the attainment of the objectives. The prime objectives of the Army Energy RDT&E

program is to provide the technological inputs required to meet the DOD and DA objectives and goals. Accordingly, the major thrust of this plan is directed towards the application and when necessary the development of the specific technologies to:

a. Utilize domestically produced synthetic fuels and alternate conventional fuels in the military mobile systems.

b. Develop a family of military engines that are capable of burning a broad range of both synthetic and conventional fuels.

c. Reduce overall energy use through efficiency improvements without compromising flexibility, readiness, or performance.

d. Achieve an adequate degree of energy self-sufficiency for military installations through reduced dependence on petroleum fuels.

e. Encourage the commercialization of domestic synthetic fuels industry capable of producing mobility fuels for military use.

An initial plan, entitled "DARCOM ENERGY R&D PLAN" (dated January 1979) was distributed for review and comment Feburary 1979 by MERADCOM.[2] As a result of this action, the present comprehensive mobility energy R&D plan (Appendix A) has been prepared. The purpose of this plan is to coherently present R&D tasks necessary for the Army to meet mobility energy needs and goals with primary emphasis on the peace-time CONUS energy environment. The plan includes:

a. History and Perspective

b. Guidance/Directives and Goals

c. Mobility R&D Tasks

d. Technical Assessments

e. Management Plan

f. Resources

g. Overall Assessments

SECTION 2. BACKGROUND

HISTORY AND PERSPECTIVE

Many documents have been written describing the energy problem as it affects the economy, life quality, national security, and military services of the United States of America.

World industrial growth during the past century has been characterized and hastened by the widespread availability of inexpensive energy, primarily petroleum. The Arab oil embargo of 1973 and subsequent energy supply interruptions served to emphasize a number of points, key among them being that the world's principal oil-consuming countries are not the major oil-producing countries. The Middle East and Africa have an estimated 67 percent of the world's petroleum reserves while Western Europe and the Western Hemisphere have only 16 percent. By most estimates, these reserves are expected to be exhausted within the next 70 years. In the 1973-74 time frame, prices for petroleum rose threefold, signaling the end of inexpensive oil. The distribution of alternative sources of recoverable oil, such as tar sands and oil shale, favor the Western Hemisphere, but economical recovery techniques to exploit these resources have not been developed to date. Coal constitutes 81 percent of the U.S. energy reserves but supplies only 18 percent of the energy consumed.[1]

The United States, with 6 percent of the world's population, consumes more than 30 percent of the world's energy. It uses more energy per dollar of Gross National Product (GNP) than any other industrialized nation. Petroleum is used primarily for transportation, coal is used principally for electric utilities and industry, and natural gas is preferred for residential heating and some industrial uses.[1]

Petroleum production in the United States peaked in 1970 and has slowed since then. As a result, in 1977 the United States imported approximately 50 percent of its crude oil requirements. Many analysts predict that the U.S. petroleum reserves will be exhausted before the year 2000, thereby creating a significant problem for the nation and the Department of Defense (DOD).

The national energy strategy is reflected in the following objectives established by the President on 29 April 1977 in the National Energy Plan I[3] and reinforced in the National Energy Plan II, May 1979.[4]

a. In the near term, to reduce dependence on foreign oil and to limit vulnerability to supply disruptions.

b. In the mid term, to keep U.S. oil imports sufficiently low to weather the eventual decline in the availability of world oil supplies caused by capacity limitations.

c. In the long term, to develop renewable and essentially inexhaustible sources of energy for sustained economic growth.

Some of the key specific national goals cited by the President, to be accomplished by 1985, are as follows: Reduce energy usage growth to 2 percent per year, reduce gasoline consumption by 10 percent, increase coal production by 67 percent, use solar energy in 2-1/2 million homes, and reduce energy consumption in Federal buildings by 20 percent in existing buildings and 45 percent in new buildings.[4]

DOD consumes 1.8 percent of the nation's energy but consumes over 3 percent of the total petroleum used by the United States. DOD established the following energy conservation goals:

FY74 - 7 percent savings over FY73

FY75 - 15 percent savings over FY73

FY76 - 0 percent growth over FY75

FY77 - 0 percent growth over FY75

FY78 - 0 percent growth over FY75

All of these goals were achieved.[1]

The Army operated under the following energy management objectives through 1977.

a. Conserve energy while maintaining readiness.

b. Maintain zero growth based on FY75 total energy consumption.

c. Maintain a supportive and cooperative role with designated national energy authorities in the development of new energy sources.[1]

After reviewing the entire energy situation looking to the year 2000 and in consideration of the presidential goals, the Army Advisory Group on Energy (AGE), on 1 December 1977, established goals and objectives which were subsequently revised in August 1979.[1] The current goals and objectives are:

<u>Goal (1)</u>

Reduce energy consumption by 35 percent by the year 2000.

a. <u>Objective (a)</u>: Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

b. <u>Objective (b)</u>: Reduce energy consumption in facilities operations by 20 percent by FY85 and 40 percent by the year 2000.

c. <u>Objective (c)</u>: Expand energy conservation education/information and incentive programs for all Army military and civilian personnel and their dependents.

<u>Goal (2)</u>

Reduce dependence on nonrenewable and scarce fuels by the year 2000.

a. Objective (a): Mobility - Develop capability to use synthetic/ alternate fuels; increase systems efficiency by 15 percent.

b. Objective (b): Facilities - Develop capability to use synthetic gas to replace natural gas; reduce consumption of heating oil by 75 percent.

Goal (3)

Attain a position of leadership in the pursuit of national energy goals.

Based on 1977 data, the Army's share of DOD energy consumption is 17 percent. Of that amount, 83 percent is consumed in installation or facilities operations and 17 percent in mobility operations. Between FY73 and FY75, the Army reduced its consumption by 23.6 percent, exceeding the DOD goal by 8.6 percent. In FY75, the Army consumed 277 trillion btu of energy at a cost of $545 million. In FY78, despite reductions of approximately 6.8 percent in consumption compared with FY75, the costs rose above $780 million. If the Army were to maintain the FY75 level of energy consumption to the year 2000, the cost of energy for that year would be expected to exceed $3.1 billion. On the other hand, if the Army meets its newly adopted goals, the costs would be $1.8 billion in FY2000, resulting in a cost avoidance of $1.3 billion. The estimate for the total cost avoidance for the 20-year period between FY80 and FY2000 would be in excess of $11 billion. These energy-related savings do not take into account the Army's industrial support energy requirements. It has been proposed that the Army use this cost avoidance in support of the funds needed to develop the Army programs to meet its goals and objectives.[1]

SIGNIFICANT GUIDANCE FOR DEFINING GOALS FOR ARMY MOBILITY AND FACILITIES ENERGY RESEARCH AND DEVELOPMENT

General Energy Objectives

The DOD, in response to the consideration of assured supply of energy, particularly mobility fuels; and in support of DOD's primary aim of maintaining

the operational readiness of our strategic and tactical forces sufficient to ensure national security regardless of energy supply conditions, has established the following general energy objectives:

a. Broaden the range of mobility fuels which can be used in military systems, with primary emphasis on domestically produced synthetic fuels.

b. Promote energy conservation with primary emphasis on the development of more efficient propulsion and power generation equipment and to reduce the dependence of military installations, particularly remote bases, on petroleum derived fuels, by promoting the use of more abundant or renewable energy sources where liquid hydrocarbon fuels and natural gas are now used.

In support of these general energy objectives, DOD has established the following specific energy goals:

a. Devise with DOE a national strategy to minimize the disruption of hydrocarbon fuels to DOD.

b. Develop propulsion systems and adequate specification and testing procedures to accomodate the use of a broader range of fuels.

c. Prepare now for the transition from use of petroleum based to synthetic fuels in the post 1985 time frame.

d. Comply with the energy reduction goals for 1985 as set forth in Executive Order 12003 to reduce energy usage in existing and new buildings by 20 percent and 45 percent, respectively, and to exceed the statutory requirement for fuel economy in the DOD passenger auto fleet.

e. Limit the level of energy usage in 1985 to that used in 1975 through improvements in propulsion systems; increased efficiency of mobile equipment used in operation and training, and through increased use of simulators in training.

f. Obtain a 10 percent use of more abundant and renewal solid fuels by 1985.

g. Obtain a one percent use of solar and geothermal energy by 1985.

h. Equip all natural gas only heating plants over 5MBTU/hr with alternative fuel capability by 1982.

i. Have on hand a 30 day fuel oil supply for all heating units greater than 5MBTU/hr.

Mobility Energy R&D Plan

A Mobility Energy R&D Plan was requested in a letter[5] from the Deputy Director, materiel plans and programs (DAMA-PPM), for the office of the Deputy Chief of Staff for Research, Development, and Acquisition (ODCSRDA) and stated that:

a. "As one part of the effort to accomplish the DOD and Army energy goals, there should be a coordinated Mobility Operations Energy R&D technology base program encompassing total projects and efforts relating to achievement of specific goals."

b. "To initiate this activity, you are requested to provide a review to the Agency and other HQDA members, and a detailed plan which clearly identifies objectives and management structure for the POM 80-84 years. In so far as possible, your plan should also address the longer range picture to the year 2000 to accomplish the Army energy goals and objectives. Your presentation should include:

a. 6.1 research programs underway, technical objectives, approach, performing organization and funding.

b. Recommendations for new 6.1 work.

c. 6.2 and 6.3a work being done and what additional 6.2 and 6.3a programs should be pursued.

d. Identification of major technology gaps, especially those that could impact any of the newly developing weapon systems.

e. Identification of potential technological opportunities."

c. "To aid in planning a complete and compreheansive technology program, the following technical/management areas should be addressed:

a. Plans for action for coordination between laboratories.

b. Plans of action for coordination with DOE and other Services.

c. Plans for participation with the DOE Shale Oil Task Group.

d. Technology transfer to system commands and program/project manager.

e. Current programs which heretofore have been classed as energy related as opposed to energy motivated."

d. "This review should involve several laboratories and a number of SPF/SPEFs. Our objective is to ensure a cohesive, coordinated program leading toward a stronger Mobility Operations Energy R&D technology base that will be capable of responding to future ROCs and the overall needs of the Army to cope with the future energy environment. The plan will serve to initiate effective, well-coordinated energy programs and provide documentation for resource allocation."

Army Energy Program

The Army Energy Program (AR 11-27) promulgates the Army's responsibilities and provides other guidance.[6] The overall objectives of the Army Energy Program are stated as follows:

a. Assure the availability and supply of energy to Army forces in accordance with mission and readiness priorities.

b. Participate in the national effort to conserve energy resources.

c. Attain, as a minimum, conservation goals established by DOD.

d. Participate in national research and development efforts toward new and improved energy sources.

e. Implement DOD energy-reporting requirements.

f. Promote Army-wide awareness of the essential need to conserve energy resources, and to foster a willingness to participate in conservation of these resources.

g. Recognize accomplishments of Army personnel in energy conservation.

Army Energy Plan

The Army Energy Plan (draft dated 27 August 1979)[1] supersedes the Army Energy Plan, February 1978, with change C1, September 1978, and contains the revised Army Energy Goals described above. The Army Mobility Energy Research and Development Plan 1980, including the Installation/Facilities section, is a comprehensive update of the Army Energy Plan excluding consideration of Nuclear related energy activities.

Other Guidance

The following documents also provide guidance to the plan.

a. DOD Energy Management Plan[7] established policy guidance for the three services.

b. Memorandum from John P. White (ASD, MRA), dated 1 March 1978, established defense energy goals and objectives, responding to executive order 12003 20 July 1977.[8]

c. Memorandum from C. W. Duncan, Deputy Secretary of Defense, dated 20 March 1978[9], established DOD assignments in support of military fuels for Mobility Action Plan.

d. Memorandum from Dr. Ruth Davis, Deputy Secretary of Defense (RIE), dated 24 July 1979, provided direction to the three services concerning a greatly accelerated DOE/DOD program to qualify, develop specifications, and prepare for procurement of Shale Oil Products by the middle of FY82.[10]

e. Memorandum from George Marienthal, Deputy Assistant Secretary of Defense (EE&S), dated 7 July 1978, established lead service responsibility for energy technologies.[11]

f. Dr. Gamota, DOD, provided a technology area description (TAD) on energy research, development, test and evaluation, draft dated 6 September 1979.[12]

g. Army policy statement on mobility energy research and development, dated 22 December 1978, established Army policy on Mobility Energy R&D, and encourages research for massive production or synthetic mobility fuels for early type classification and use in Army equipment.[13] It further encourages R&D to improve fuel efficiency of equipment through new design and economic retrofit of old equipment and R&D to permit development of systems capable of using a broad range of synthetic and conventional fuels.

h. The "Army Environment 1985-95" study by the Strategic Studies Institute, Army War College, contains numerous references to energy needs and resources as an item of major interest to the Army of the future.[14]

i. The Science and Technology Objectives Guide (STOG) is a user's document which identifies force needs and requirements. The STOG plays an important role in establishing the parameters on which future equipments and weapons systems will be structured.[15]

ARMY ENERGY ORGANIZATION AND RESPONSIBILITIES

The department for the Army organization for energy consists of the following key elements:

a. A special assistant for energy located in the Office of the Assistant Secretary of the Army (Installations, Logistics, and Financial Management), the AGE, and the AEO. These elements are backed up by the Army staff through the staff agency points of contact. The Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA) and the Chief of Engineers (COE) have major separate responsibilities in the energy area.

b. The Special Assistant for energy is the Deputy for Logistics within the Office of the Assistant Secretary of the Army (Installations, Logistics, and Financial Management) (OASA (IL&M)).

c. The Advisory Group on Energy (AGE), organized under the authority of AR 11-27, is a general officer level body. The director of transportation, energy, and troop support of the Office of the Deputy Chief of Staff for Logistics (ODCSLOG) chairs the AGE. The Secretary is the Chief, AEO. The AGE has the following functions:

(1) Continually review Army policies, programs, and procedures for their impact on energy and recommend corrective action when necessary.

(2) Provide a forum for the exchange of information and ideas and determine actions required to attain presidential or DOD-established goals for energy conservation and energy self-sufficiency.

(3) Develop and provide recommendations on urgent energy matters.

d. The Army Energy Office (AEO) is under the Directorate for Transportation, Energy, and Troop Support, ODCSLOG, with the general staff responsibility for the following energy-related functions:

(1) Supervising and coordinating the Army Energy Program.

(2) Formulating and recommending coordinated Department of Army (DA) policy for the allocation, supply, and use of energy resources within the Army.

(3) Developing and executing a comprehensive energy conservation program.

(4) Providing principal Army Staff Advisors and contact on energy -related matters to the Office of the Secretary of Defense (OSD), Office of Management and Budget, the Congress, and other military and government departments and the civilian sector.

(5) Participating in the budgetary process for the Army Energy Program within overall guidance and policies developed by the Director of the Army Staff and the Comptroller of the Army.

e. Army Staff Agencies responsibilities:

(1) ODCSOPS - Establish priorities, ensure energy considerations are introduced into unit training and exercises and material requirements, and ensure energy conservation is incorporated in the curriculum of schools and individual training programs.

(2) DCSRADA - Initiate research and development actions to conserve energy, consider energy conservation in the development, acquisition, manufacture, operation, and use of Army material.

(3) DCSPER - Emphasize energy conservation in the incentive awards program and other personnel-related programs.

(4) COA - Assist Army staff in development of energy-related budgeting actions.

(5) COE - Develop and manage the installations and utilities element of the Army Energy Program, including construction and serve as principal Army Staff Advisor on utilities services.

(6) TSG - Ensure health and preventive medicine aspects of Army Energy Program and Plan are adequate.

(7) CPA - Develop and execute command and public information support for the Army Energy Program and Plan.

(8) All Staff Agencies - Ensure that energy considerations are included in agency functional responsibilities, coordinate energy matters with the Army Energy Office, and establish a single point of contact for energy matters.

f. Commanders at all levels, down to and including Installation Commanders, are encouraged to establish and use command energy councils or committees. Further responsibilities include developing and maintaining an active command energy program to include a comprehensive energy plan. Major commands are required to provide copies of their plans to AEO and provide annual updates. DARCOM has been tasked by DCSRDA to develop the mobility element of the Army Energy R&D Plan. MERADCOM has been designated the lead/coordinating activity within DARCOM. The COE has been tasked by DCSRDA to develop the facilities element of the Army Energy R&D Plan. CERL has been designated the lead/coordinating activity within COE.

SECTION 3. PLAN OF ACTION FOR ARMY MOBILITY ENERGY R&D

Many of the new high-mobility, high-maneuverability equipment have increased rather than decreased fuel requirements. A major example is the XM1 tank which will be powered with a turbine engine. To achieve the higher speeds required by the user and to power the additional tank-borne equipment items will require much higher fuel consumption rates. This, in turn, will increase the logistic requirements factor in terms of the additional tankers, pipelines, pumps, etc., required to meet the increased needs. A similar statement may be made for most mobility equipment, whether land or air. Therefore, the incorporation of energy factors into the specifications for design and engineering of future Army combat mobility and operational requirements will require additional resources as well as tradeoffs of other requirement considerations. For this reason, the specific nature of the Army's program in force structuring (equipment) will require very careful analysis and critical judgments.

The Army Mobility Energy R&D Program provides a framework to reduce use of mobility fuels through improved engine efficiency, to develop multifuel engines, and to provide for introduction of synthetic fuels and alternative energy sources in Army mobile equipment. The program has been planned, additionally, with sufficient scope to include all nonfixed facility fuel consuming equipment and to accommodate energy conservation as well as energy supply objectives.

ORGANIZATION PLAN

Figure 1 illustrates how projects originate within the Army Mobility Energy R&D Plan. The project sources shown in the figure have been selected as examples of numerous additional sources that could be cited. Communications between the subcommands (MERADCOM, et al.) and project sources are

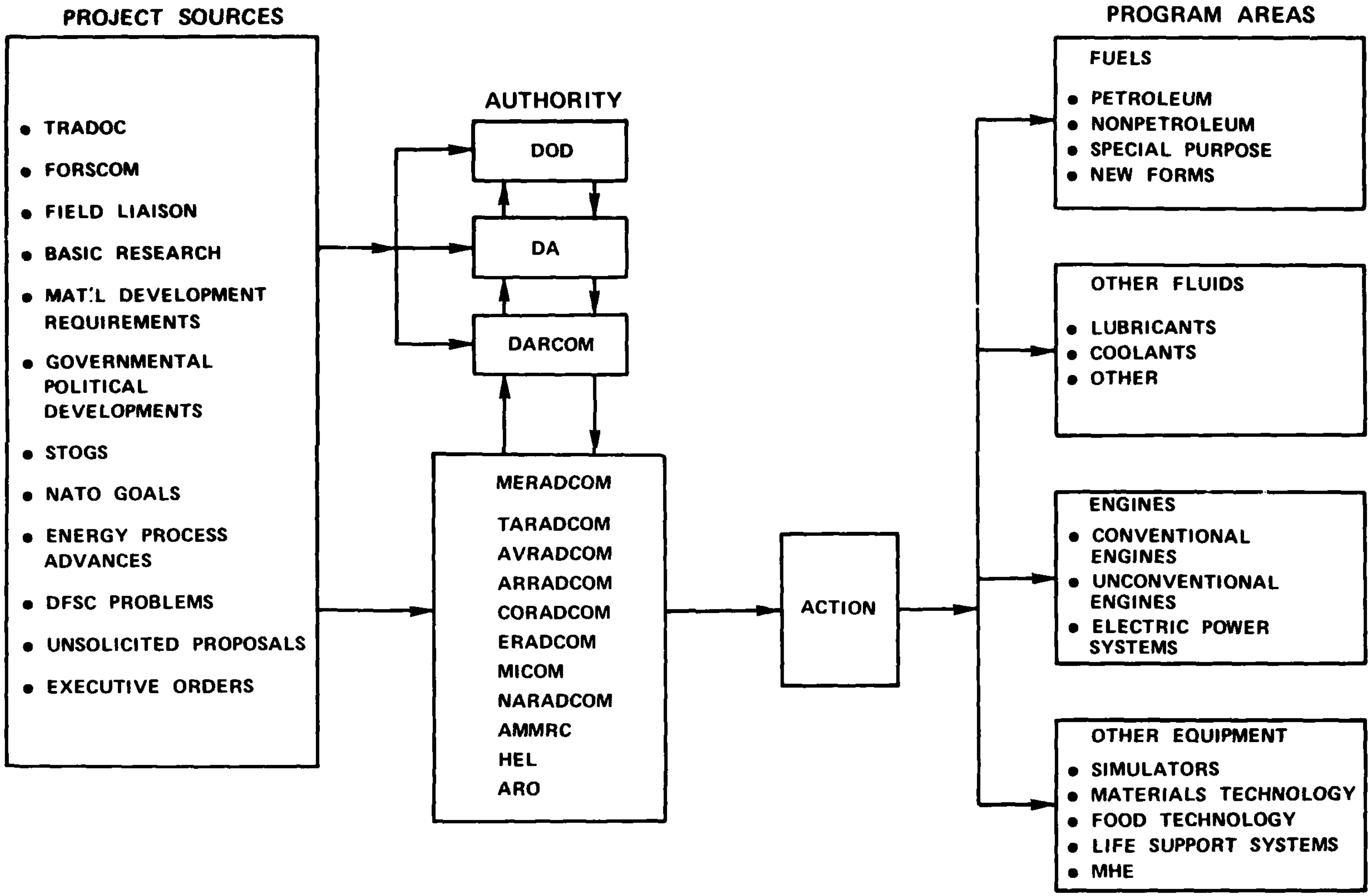


FIGURE 1. ARMY ORGANIZATION FOR MOBILITY ENERGY R&D PROGRAM

unrestricted, but authorization for specific projects must be received via the DA-DARCOM authority process. However, project activities can and should be adjusted by the subcommands as appropriate within the scope of the authorized program elements. Some project areas require special intra-DOD coordination, a good example being in which the USAF had lead service responsibility for turbine fuel development and the Army/AVRADCOM is a major helicopter engine -developer/turbine fuel user. Similarly, the Army/TARADCOM-TARCOM, in its ground vehicle selection support role for DOD, must interface with the USN and USAF energy plans to ensure commercial ground vehicle procurements are consistent with energy goals.

Each of the subcommands and laboratories which conduct energy-related projects submit periodic summaries ("Prioritized Command Objectives") to MERADCOM. MERADCOM consolidates these summaries into the overall program plan. Briefings on the consolidated plan are then held at DARCOM, DA, and DOD levels to provide visability and to recommend adjustments, authorization, and funding.

The Army Mobility Energy Research and Development Program can be categorized into four elements -- fuels, other fluids, engines, and other equipment. Figure 1 also identifies the subelements under which the individual projects are assigned. The elements under "Fuels," "Other Fluids," "Engines," and other "Equipment" are sufficiently broad to accommodate all product-oriented possibilities. Operational, procedural, and other soft-science projects which either conserve fuel or improve its availability are also performed under the program elements.

It also becomes evident in considering Figure 1 that this organizational framework forms the technical heart of the Army Mobility Energy R&D Plan.

TECHNICAL ASSESSMENT

A critical part of a plan for the mobility energy R&D is an assessment methodology. The assessment methodology is necessary to:

a. Categorize projects as energy related and the degree of their contribution to meeting the DA Energy Goals and assign these projects a priority for implementation.

b. When required, provide an assessment of the worth of the project from an energy view point.

c. Assess the degree to which funded projects will satisfy DA Energy Goals.

d. Determine voids and gaps still remaining.

e. Provide date for project recommendations.

The assessment function needs and requirements are discussed in more detail in Section IV, "Management Plan."

Seventy-nine energy-related/supporting projects were submitted by all of the DARCOM R&D commands as input for development of this plan. Since a structured assessment methodology did not exist, a subjective scheme was devised to initially assess these proposed projects. The projects are summarized in paragraph D of this section along with their "subjective rating" and any pertinent recommendations. The preliminary numerical value system established for the subjective assessment process (also referred to as energy relevance) is shown in Figure 2. Point values of 1 to 5 are assessed depending on the relevancy of the proposed project to Army Mobility Energy R&D Program. After the assessment methodology, scheduled to be accomplished during FY80, is developed, the inputs will be reassessed, and the results incorporated in an update of this plan.

ASSESSMENT VALUE
(ENERGY RELEVANCE)

NOTE: MAKES NO JUDGMENT ON PROJECT TO MEET ARMY REQUIREMENTS; ONLY ITS CONTRIBUTION TO ARMY MOBILITY ENERGY R&D

VALUE (FOR MOBILITY ENERGY R&D)

5 – MUST PROGRAM, SHOULD BE FUNDED
EXCELLENT ENERGY SUPPORT

4 – HIGH POTENTIAL, SHOULD BE FUNDED
HIGH ENERGY SUPPORT

3 – GOOD, FUNDED IF MONIES EXIST
GOOD ENERGY SUPPORT

2 – MARGINAL, LIMITED SUPPORT TO ARMY ENERGY GOALS

1 – UNDECIDED, NEED TO EXAMINE IN FY80 TO DETERMINE IF IT SHOULD REMAIN IN ENERGY PLAN

0 – NOT ENERGY RELATED

MARK (FOR 6.1 PROJECTS)
+ 0 RELEVANT
– 0 NOT RELEVANT

Figure 2

TECHNICAL PERFORMANCE PLAN

The Program Performance Plan is illustrated in Figure 3. The progress routes pass through four phases of effort, any one of which may lead to the output examples shown. Two important messages are communicated by Figure 3.

a. The traditional RDT&E phases required for most hardware items are not generally sufficient for the progress of alternative fuels to final utilization. DOE recognized this some 4 years ago when preparing the first national energy plan.[16] It was concluded that alternative fuel processes would require significant demonstration phases in order to eliminate economic uncertainty barriers to commercial production. DOE thus added demonstration phases to all of their alternative fuel projects and used the initials RD&D to define their progress phases. They did not eliminate the T&E phases, but chose instead to consider them to be parts of the development phase.

In recent months, it has become apparent that demonstration phases intended for energy source process methods are insufficient for continuing the progress from process yields into finished fuel forms. Numerous process development projects have been undertaken by DOE, and many have resulted in the production of pilot batches of synthetic fuel components. Ironically, only a few of these components were every blended into finished fuel compositions and fewer still were ever demonstrated in the field. To date, the Navy is the only organization that has actually made special arrangements for the production and standardization of finished fuels from oil shale. They have, in effect, identified the necessity for P&S phases for all new finished fuel compositions. DOE has also recently recognized that special phases are required to produce and standardize finished fuels containing nonpetroleum components. Their pending national road test[17] of alcohol/gasoline fuel blends has required that special attention be given to the P&S activity.

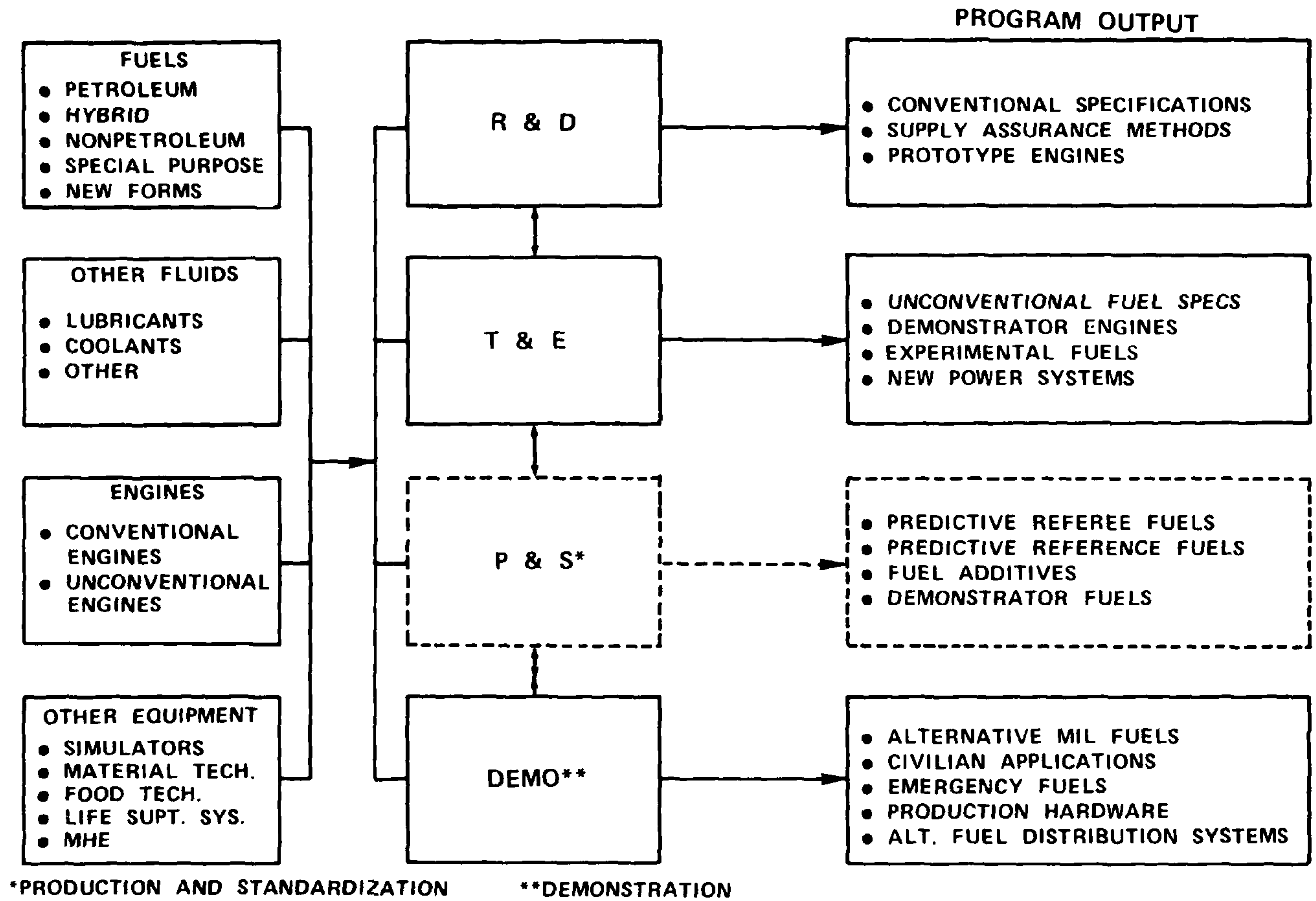


FIGURE 3. ARMY ENERGY PROGRAM PERFORMANCE ELEMENTS

Note in Figure 3, that the P&S phases are enclosed with dashed lines to signify the uncertain responsibility for these functions. Whether considered by DOE, DOD, or another agency, these functions must be addressed to ensure future synthetic fuels availability.

b. Progress toward the end application of energy projects does not necessarily pass through all phases of Research and Development, Test and Evaluation, Production and Standardization, and Demonostration (RDTEPS&D) in an orderly manner. For example, conventional fuel specifications are usually developed as modifications of preceding specifications. The finished product is a document which is not usually identifiable with other physical RDT&E work. Figure 3 thus lists "conventional" fuel specifications as a completed output from the R&D phase. "Unconventional" fuel specifications, however, usually involve T&E activities as well as prior R&D work. The predictive referee fuels shown under the P&S phase represent fuel examples that must proceed through R&D and T&E phases. As the name implies, "predictive" referee fuels are compositions that can be blended today as "best estimates" of fuels expected in the future. Such fuels are urgently needed to aid the development of future engines. Obviously, the P&S phase is also essential for the preparation and supply of special fuels such as the fuels (600,000 barrels) from oil shale that are required for the forthcoming DOD program.[18] Obviously, too, the P&S phase is a necessary, but separate, activity from the Demonstration phase.

Figure 4 is an expansion of Figure 3 to provide an overall representation of the Army Mobility Energy R&D program performance. It should be noted that Figure 3 was prepared to illustrate the flow routes of project efforts within the mobility energy plan. Figure 4 additionally illustrates the flow routes of communications that are required to keep the program in perspective with

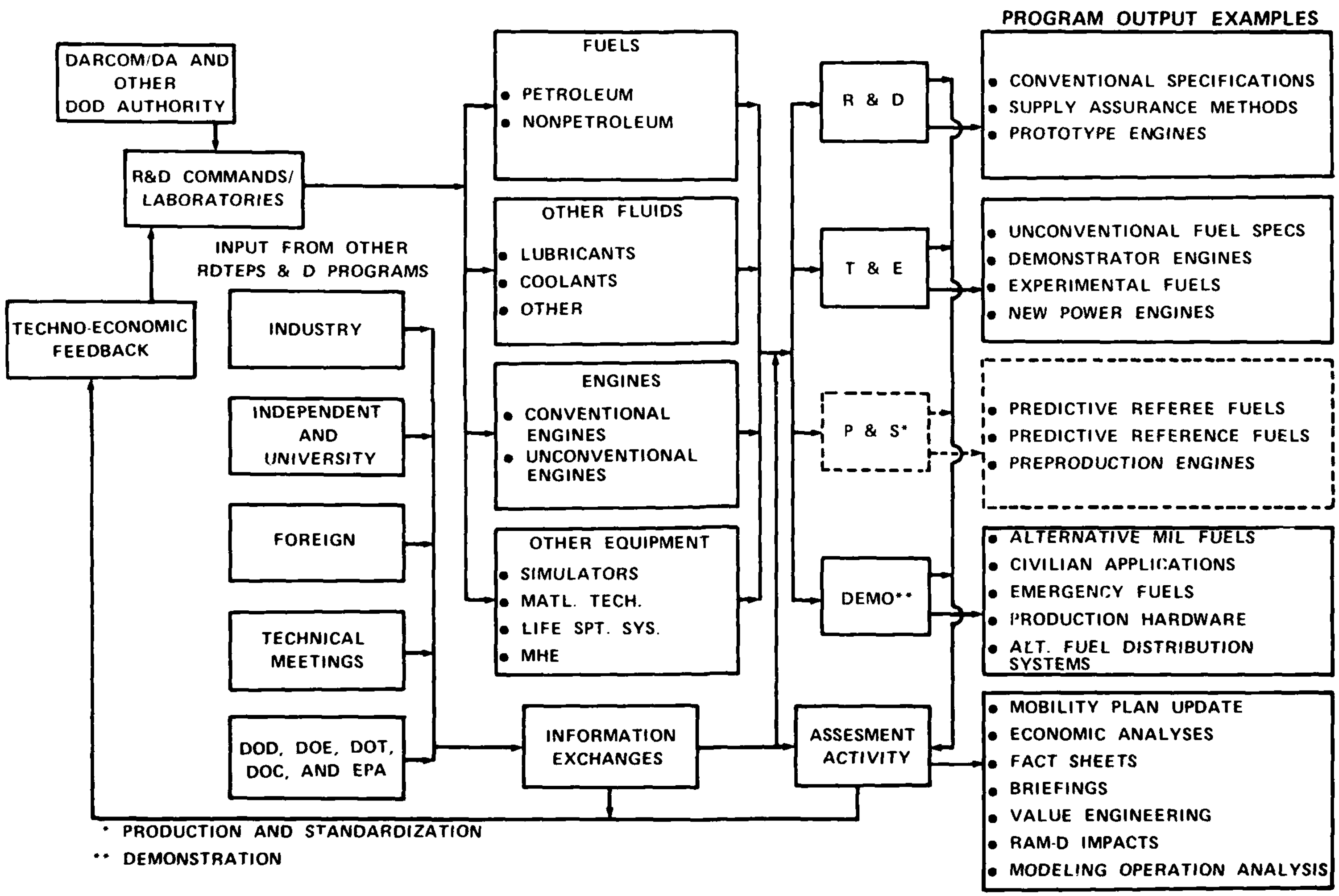


FIGURE 4. OVERALL DIAGRAMATIC REPRESENTATION OF ARMY MOBILITY ENERGY PROGRAM PERFORMANCE

Army goals and objectives. The DARCOM program is controlled and optimized via DARCOM/DA and DOD authority, information exchanges, and an assessment activity.

The influence of DARCOM/DA and other DOD authorization on the program is obvious and needs no additional explanation. Likewise, the necessity for information exchanges and surveillance of other RDTEPS&D activities is also well recognized. The assessment activity functions as a vital part of overall coordination by MERADCOM. Its purpose is to bring the results of the fuels, other fluids, engines, and other equipment projects into perspective with Army logistical, tactical, combat, and other national objectives. Its function is to minimize the conduct of marginal, nonrelevant, and uneconomic projects as well as to advocate emphasis on projects that are more economical and defense oriented. Additionally, the assessment activity will result in continuing (vis-a-vis periodic) adjustments of the physical project activities, thus assuring maximum performance efficiency of the program and providing a yardstick measurement of successful goal achievement.

TECHNICAL PROGRAMS

Throughout the Army, there are many energy uses (Figure 5). There are also many mobility-related research and development projects. The initiatives for the projects may be traced to various sources. The Army Mobility Energy R&D Program has subdivided technology for mobility operations into four program areas:

a. Fuels.

b. Other fluids.

c. Engines.

d. Other equipment.

Discussions of each of the program areas include background information, current programs, and a technical assessment with respect to mobility energy

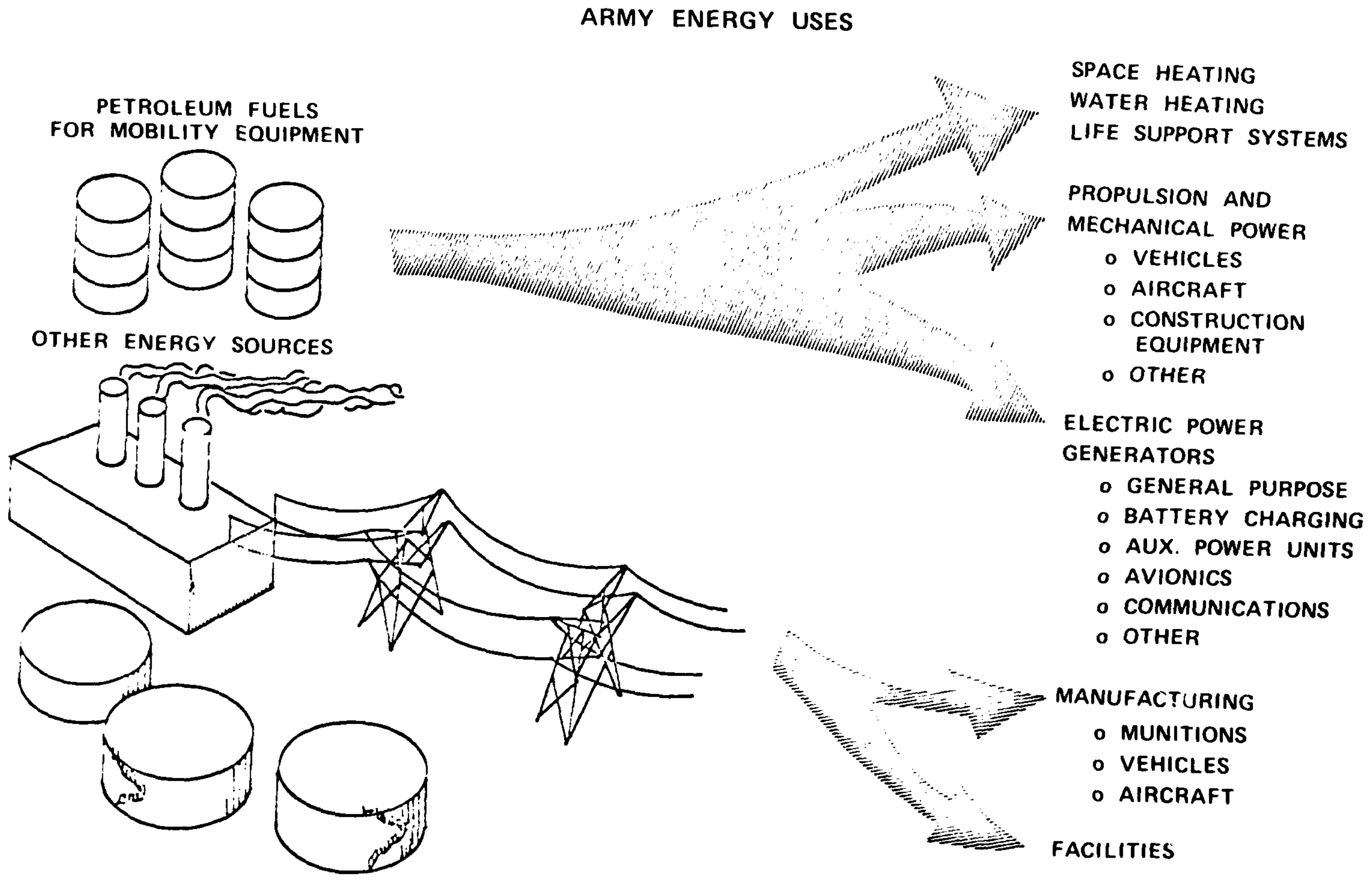


FIGURE 5. ARMY ENERGY UTILIZATION

goals and objectives. A set of spider charts (figures 6 to 10) illustrates the relationship of projects to Army Energy R&D Goals/Objectives. An overall assessment of mobility energy plans and actions is provided in a separate section.

Fuels

a. Background

(1) The fuels portion of the Army R&D plan emphasizes finished fuels technology. This is an activity that is readily distinguished from processing and refining activities. The technical scope leading to most finished fuel possibilities is illustrated in Figure 11. This figure identifies only some of the large number of fuel components that may be combined, along with desirable additives, in the blending of finished fuel compositions.

(2) A general misconception persists that finished fuel compositions are established by the refiners and processors. Such compositions, usually described in terms of their physical, chemical, and performance properties, are established by organizations which function independently of refining and processing activities. The organizational structures in the petroleum industry are good examples. Most of the major petroleum organizations have separate product development and technical service divisions which specialize in finished fuel and lubricant components. Some even have essentially autonomous chemical companies that supply additives to the "competitive" refiners.

(3) The formulation and performance properties of additives and finished fuels (including lubricants and related fuels) are the primary technical strength of the product development organizations. From this technology base, the petroleum industry --

DA GOAL	TECHNICAL PROGRAM AREA	PACING PROBLEM(S)	COMMAND	ENERGY RELEVANCE	PROJECT TITLE/REF NO.
2a(2) Improve Efficiency of Mobility System by 15% by year 2000	Engines		ARO	1	Engine Combustion Research (75)
			AVR	5	Improved Helicopter Engine (17)
		Development of Variable *Geometry Compressors* and Turbines	AVR	3	Variable Capacity Engine (18)
		High Temperature Materials and Durability of Heat Recovery Components	MER	4	Advanced Head Engines (21)
			TAR	3	Turbine Combustion Research (7)
			TAR	3	Advanced 1000 HP Diesel Engine (10)
			TAR	3	ACT-1500 Fuel Economy Program (4)
			TAR	4	Adiabatic Diesel Engine (1)
			TAR	4	Advanced Turbine Components (8)

Figure 6

DA GOAL	TECHNICAL PROGRAM AREA	PACING PROBLEM(S)	COMMAND	ENERGY RELEVANCE	PROJECT TITLE/REF NO.
1a. Reduce Petroleum Consumption by 10% by 1985	Fuels	Correlation Between Lab and Field	MER	4	Fuel Stability and Test Development (27, 28)
	Other Fluids	Correlation Between Lab and Engine Tests	MER	2	Use of Recycled Oils (26)
			MER	2	Long Life Coolant System (23)
	Other Equipment		HEL	4	Training Device for Artillery Crews (53)
			MER	2	Training Simulator for Bridging (14)
		Simulation Techniques	NAR	2	Airdrop Simulation (43)
		Approval by FDA and USDA of Food Process	NAR	2	Radiation Preservation of Foods (36)
		Development of Heat Pipe Griddle	NAR	1	Efficient Field Oven/Griddle (38)
			TAR	3	Advanced Hydromechanical Transmission (11)
			TAR	2	Simplified Test Equipment for I.C. Engines (16)

Figure 7

DA GOAL	TECHNICAL PROGRAM AREA	PACING PROBLEM(S)	COMMAND	ENERGY RELEVANCE	PROJECT TITLE/REF NO.
2a(1) Convert 20% of Mobility Operations to Synthetic or Alternate Fuels by year 2000	Fuels	Availability of Fuel; Unknown Storage Characteristics	MER	5	Alternate/synthetic Fuels (24, 25)
			MER	4	Gasohol Evaluation (79)
		High Cost; Poor Engine Performance	MER	3	High Energy Fuels (29)
		Enzyme Production; Substrate Pre-treatment; Fermentation of Hydrolyzates to Ethanol	NAR	4	Enzymatic Hydrolysis of Cellulosic Materials (37)
	Engines		AVR	5	*Multi-source Fuel Engines for Aircraft* (77)
			AVR	5	Improved Helicopter Engines (17)
			MER	4	Alternate/Multifuel Engines for MEP (18)
			TAR	5	Multifuel Engines for TAC/COMB Vehicles (76)
			TAR	5	Engine Concepts for Alternate Fuels (2)

Figure 8

DA GOAL	TECHNICAL PROGRAM AREA	PACING PROBLEM(S)	COMMAND	ENERGY RELEVANCE	PROJECT TITLE/REF NO.
2a(2)	Other Equipment	Material Reliability, Fabricability, Cost	AMM	4	Ceramic Component Technology (46)
			AMM	3	Heat Engine Vehicle System Materials (47)
		Development of Materials Suitable for Army Service/ Environment Requirements	AMM	2	Composite Structural Vehicle Components (44)
		Design of Efficient Heat Exchanger; Development of Electronic Control Systems	MER	3	Efficient Environmental Control Equipment (22)
		Development of Graphite Intercalation Compounds for Improved Conductors and Low-loss Laminations of Amorphous Metal	MER	3	Efficient Mobile Electric Power System (20)
			MER	2	Efficient Army Watercraft (35)
			TAR	2	Advanced Composite Materials/ Structures (3)

Figure 9

DA GOAL	TECHNICAL PROGRAM AREA	PACING PROBLEM(S)	COMMAND	ENERGY RELEVANCE	PROJECT TITLE/REF NO.
2a(1)	Other Equipment		HDL	1	Samarium-cobalt Generator Technology (49)
		Stability and Reactivity Catalysts	MER	5	Fuel Cell Power Plants (19)

Figure 10

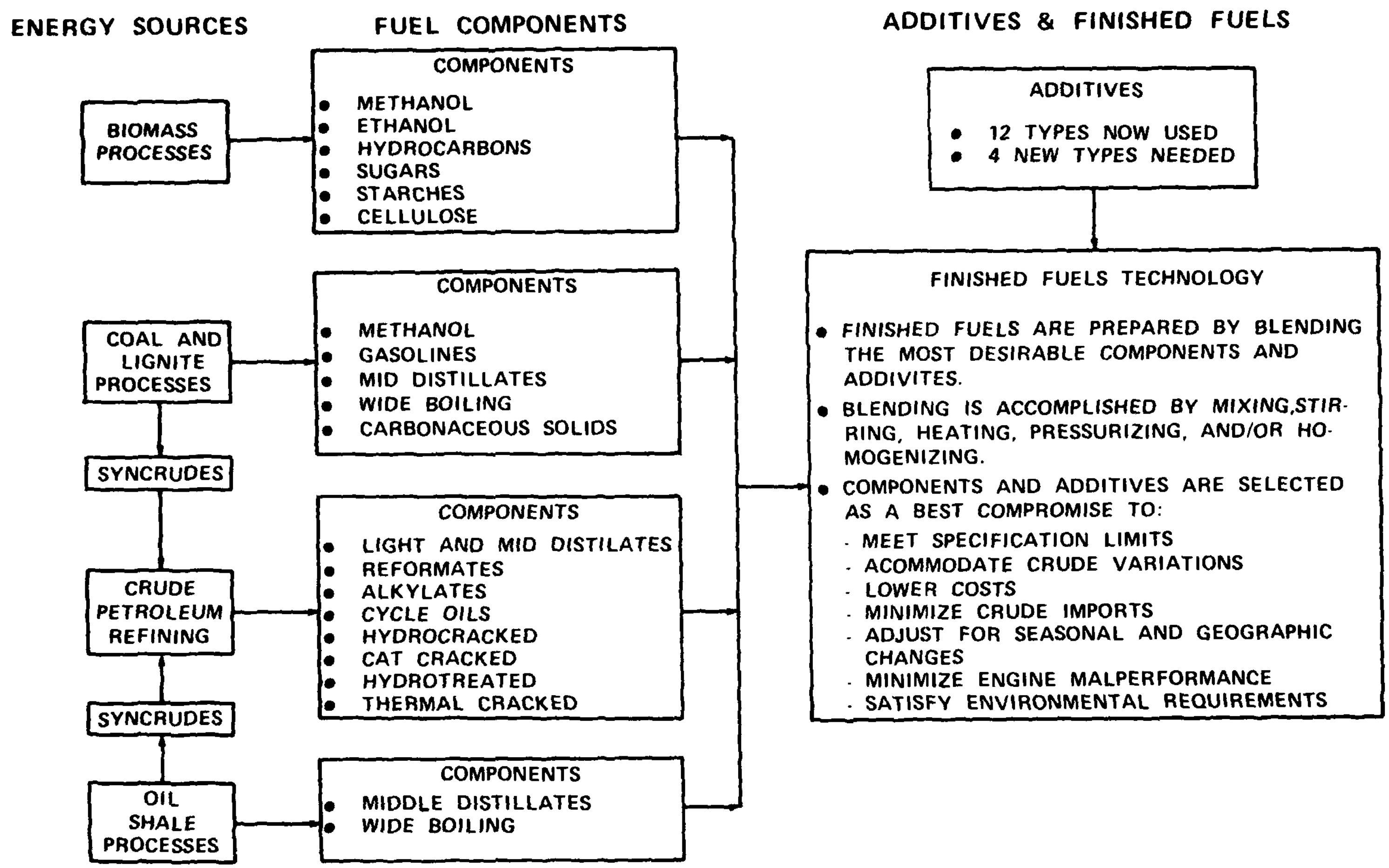


FIGURE 11. FINISHED FUELS TECHNOLOGY

(a) Maintains a continuing RDT&E program to adjust their branded and specification products towards more economic compositions -- as feed stock change, as refining technologies advance, and as new additives become available.

(b) Develops and introduces new chemical additives and finished products.

(c) Participates in the establishment and revision of fuel specifications to satisfy the major changes in engine, environmental, social, and economic conditions.

(d) Interfaces with government, consumer, and engine manufacturer.

(e) Communicates requirements of consumers and engine manufacturers to refiners and chemical companies.

(f) Tests and evaluates competitive products.

(g) Provides guidance on future fuel compositions to engine manufacturers.

(4) The important aspects of this petroleum industry activity is its correlation with the fuels portion of the Army Energy Mobility R&D Plan. DARCOM, through MERADCOM and the Army Fuels and Lubricants Research Laboratory, has long maintained close liaison with this part of the petroleum industry. Through this liaison, the Army maintains awareness of fuel composition trends on an international as well as national basis. The information gained forms a basis for the preparation of military fuel specifications which correspond with the most widely available commercial fuels. Likewise, areas of fuel quality and performance <u>germane</u> <u>only</u> to the military, i.e., long-term storage stability, broad seasonal usage of a product, etc. must have Army R&D emphasis to assure maximum military readiness.

(5) The current world shortage of petroleum supplies, along with national efforts to develop fuels from nonpetroleum sources, adds new importance to the area of finished fuels technology. The technology, as it exists today, is essentially oriented toward fuel finishings with petroleum components only. As illustrated by Figure 11, it is obvious that nonpetroleum components are now destinied to be used, either individually or in blends with petroleum components. Very little information has been developed on the performance properties of the numerous nonpetroleum component possibilities when used in engines. The identification and evaluation of these components with and separate from petroleum components will be a critical prerequisite to appropriate future military fuel specifications.

(6) Though the energy shortfalls during the 1970's has emphasized the critical interaction of fuels and the military's ability to suggest combat missions, the Army has for years carried out fuels R&D programs directly applicable to future fuel studies. Some examples are:

Broad Base "CITE" Fuels Development-1964

Ammonia Fuel (Mobile Energy Depot)-1966

Army Energy R&D Plan--1971-73

Universal Fuel Studies Broaden Diesel Fuel Specifications--1973-76

Evaluation of USN COED Fuel By products and Tar San Kerosine--1973-74

Assessment of H_2 as Vehicle Fuel--1974

Crude Oil Characteristics Program and Direct Use of Crude Oil in Army Engines as Emergency

Evaluation of Paraho I and Paraho II--1975-80

Cooperative DOE/BETC-Army, Synthetic Fuels Stability Program--1976-78

Cooperative DOE/TP-Army, Alcohol Fuels/Lubricants Requirement--1976-81

Army Mobility Fuels Scenario--1978-79

b. Current Programs

(1) MERADCOM Fuels and Lubricants Division currently are conducting R&DTE projects in the following fuels/energy-related areas:

(a) Alternate/Emergency Fuels - This has involved determining the suitability for using fuels refined from non-conventional sources, hybrid mixtures, and/or direct use of crude oil. Second generation synthetic fuels from shale crude were provided in late FY79 as part of the Defense Fuels Mobility Plan. These fuels will be evaluated in connection with a recent DOD thrust to allow use of shale-derived synthetic fuels in Army equipment by mid FY82. Concurrent with this, a recent request by the secretary of the Army has resulted in initiating a program to evaluate GASOHOL in military tactical equipment. Areas of concern regarding use of GASOHOL are system compatibility, marginal lubrication, and storage stability.

(b) High Energy Fuels - The development of new high energy fuels and/or energy augmentation additives has been underway for 2 years. The purpose is to increase the calorific value of a fuel thereby increasing the range of vehicle operation and improving the operating efficiency of tactical/combat power plants. Preliminary data have identified carbon suspensions (up to 17%) in diesel fuel using emulsifier/stabilizers to ensure a homogeneous solution and high density liquid hydrocarbon fuels designed for missile engines (i.e., JP-10) as prime contenders. Single cylinder engine tests have been conducted with these candidates and increases in engine output were evidenced. Further experimentation will involve evaluation of candidate prototypes in multicylinder engine tests.

(c) Diesel Fuel Deterioration - This has evolved as a result of fuel degradation problems occuring at various Army depots. A field go/no-go

test kit is being developed as well as an additive stabilizer system for depot use. More recently, as a result of interest expressed by U.S. Forces in Europe, a cooperative program was initiated to provide a fully-fueled capability for vehicles in storage in conjunction with the POMCUS program. Additional field testing of the candidate additive stabilizer package at several CONUS Army activities has been planned. One recent example has been to use this stabilizer package for new M60 tanks being stored for up to a year at the Chrysler tank plant facility.

(d) High Sulfur Fuel Utilization - Since a majority of our combat equipment is powered by two-cycle diesel engines which have a well-defined fuel sulfur limitation (not to exceed 0.7 wt%), this effort has considered a methodology to allow use of high sulfur fuels in these engines by either a (1) fuel additive or (2) lubricant reformulations. From data developed to date, it appears that the lubricant "Fix" may be the more successful approach. A full-scale DD6V-53T diesel engine test will be conducted prior to establishing the proposed field fix policy.

(e) In addition to the above 6.2 funded projects, the 6.1 energy-related initiatives have been identified as Combustion and Work Cycle Efficiencies as Function of Multicomponent Fuel Properties.

c. Technical Assessment

(1) Table 1 shows a composite presentation of all project synopsis appearing in Appendix A. Each project has been rated against five energy objectives using the preliminary numerical system shown in figure 2. The scheme allocates the numerical rating based on the relevance of the project to the Army Mobility Energy R&D Plan, including considerations as to the probability of meeting the target goal by the time specified. It does not make

TABLE 1. FUELS EVALUATION

REQUIREMENT	PROJECT Alternate/Synthetic Fuels 024 025	Fuel Stability and Test Development 027 028	High Energy Fuels 029	Enzymatic Hydrolysis of Cellulosic Material 037	Gasohol Evaluation 079
DA GOAL/OBJECTIVE					
1a. Reduce Consumption by 10% (1985); Zero Growth (2000)		X			
Improve Engine Efficiency					
Increase Simulators					
2a. (1) Develop capability to use synthetic/alternate fuels	X		X	X	X
Multifuel Engines					
Shale Oil Products					
Unconventional Liquid Fuels			X		
Transition/Specs					
2a. (2) Increase efficiency of Mobility Systems by 15%					
3. Position of Leadership in pursuit of National Goals	X				
SPECIAL INTEREST					
DA					X
DOD	X				
Assessment/Energy Relevance	5	4	3	4	3

judgment as to whether the project meets specified Army requirements and is technically sound. Only ongoing projects as of August 1979 are considered.

(2) The majority of all existing fuel projects relate to potential synthetic fuel utilization and the R&D data base needed to affect a smooth transition from conventional petroleum-derived fuels. These projects assume production of synthetic fuels by DOE, DOD or industry within a 1- to 2-year time frame. As of this date, only the processed 100,000 bbl of Paraho shale oil (Navy) can be considered available for such R&D programs. No processed fuel schedule has been found which projects estimated availability time frames for synthetic fuels. Without clearer advanced planning direction, it will be difficult to justify programs, funding levels, and equipment/personnel R&D needs. Likewise, no clear policy has been found which indicates whether or not DOD will be receiving processed fuel products refined from 100-percent syncrudes or from blends of syncrudes and petroleum crudes. If the syncrude/synfuels industry grows incrementally, replacing 10-20 percent of the refinery petroleum crude input over the next 10 years, the transition may not require major end-use R&D like that required for fuels produced for 100-percent syncrudes. Again major assessment programs coordinated with DOD, DOE, and industry appear to lack the present program outlay.

(3) In receiving the DA energy goals and the distribution of energy-consuming factions within DA, it is questionable whether or not the mobility sector (17 percent of DA consumption) can significantly add to the reduction in fuel consumption by 10 percent (1985) and maintain zero growth levels through the year 2000. Figure 12 shows fuel consumption patterns comparing Army consumption of petroleum for FY77 and FY79. There is an overall

Quantity (Million Gallons)

	FY77	%	FY79	%
Heating	439.5	57.5	378.1	54.1
Jet Fuel	97.1	12.7	96.6	13.8
Diesel	97.1	12.7	104.7	15.0
AvGas	5.4	0.7	3.4	0.49
MoGas	125.3	16.4	116.5	16.7
Total	764.4	100	669.3	100

Figure 12. Army Petroleum Consumption

decrease in consumption but individual elements show increases. Pressures on increased combat force mobility and the resulting equipment density increases; and potential increases in force structure size through FY2000 may offset any potential fuel reduction from RDT&E efforts. Obviously energy conservation can help. Development of synfuels compatible with today's equipment is also important but again there appears to have been no assessment guidance indicating which energy goals should be emphasized by which using sector. For example: fixed DA facilities use 83 percent of the energy and therefore may be the best place for funding projects directed at fuel-reduction goals. Likewise, fixed facilities may be the best place to utilize the first syncrude-refined product since large heating units are less sensitive to fuel composition than aviation turbines.

(4) In attempting to develop multifuel engines, it appears that a fuels' R&D program, in conjunction with DOE and industry, should evaluate the economic potentials of producing a minimally refined fuel which could become the normal fuel for future mobile ground vehicles. There is no economic justification to assume fuels meeting today's petroleum specifications can be produced from syncrudes without substantial cost penalties. Obviously multifuel engines need to be insensitive to a broad spectrum of finished fuel classes, but the engine developer needs a better definition of tomorrow's fuel today.

(5) Similarly it has been DOD policy that the Air Force maintain responsibility for development and specification control of Army aviation fuels. However, as the Air Force develops engines with larger thrust which will be larger and the Army attempts to decrease the size of its turbine engines, fuel requirements, as they relate to composition, for these newly designed engines will

inevitability diverge. An aviation fuel developed to satisfy the requirements of an engine suited to Air Force needs will not meet the requirements for the smaller Army turbine engines. An assessment of the needs of small Army engines appear to be warrented in the next one to three years.

Other Fluids

a. Background/Current Programs. The terminology "other fluids" includes but is not limited to antifreeze, engine lubricants, hardware greases, hydraulic fluids, and special-purpose hardware preservative fluids. Each of these materials generally originates from petroleum crudes and, though procured in small quantitites as compared to the overall Army energy needs, is a major factor in military equipment RAM-D. All such fluids are procured by military specification and, in most cases, will have composition or performance requirements different than like commercial products. Therefore, Army R&D on these fluids is an expansion of the existing commercial data base. Some examples are:

(1) Antifreezes under MIL-A-46153 became scarce during the 1973 energy embargo due to the production shortfall of ethylene glycol derived from petroleum feed stocks. Commercial antifreezes did not meet the Army specification in the areas of corrosion protection of the military engine cooling system hardware, or the extended use period of 4 years (commercial good for only one year). As a result, MERACOM R&D has developed a promising inhibitor package which may provide a means of upgrading deteriorated antifreeze and thus extending the useful life of existing stocks. A second program is developing a filter/conditioner which can filter the coolant to remove insoluble degradation and corrosion products while slowly releasing new inhibitor chemicals into the coolant life and drastically reduce the volume of ethylene glycol procurement in the future years.

(2) Multiple R&D activities at MERADCOM are addressing military engines oils. These programs include development of re-refined oil quality control to permit use of such fluids, thus extending the life of these hydrocarbon products with a comparable decrease in procurement requirements for original resources. Development of new lubricants which can be made from renewable resources, development of year-around lubricants which reduce oil drains, development of a single lubricant for vehicle engine crankcase and drive trains, and quality analysis techniques to determine lubricant changes only when quality degradation is detected, all have direct energy/economic benefits to the military while increasing equipment readiness. These same lubricant programs may improve mechanical friction reduction, thus reducing vehicle energy consumption per unit of work. Programs in greases and preservation fluids have benefits of requiring less equipment maintenance, spare parts procurements, and equipment deadlining, creating a secondary energy benefit by reducing logistics and manufacturing pressures.

(3) Reconditioning of cleaning solvents or the use of waste petroleum products as fixed facility and mobile powerplant fuel extenders provides a secondary use of fluids which in the past have been disposed of by waste pit burning and other elimination methods. Programs to study such secondary uses interface with the COE energy plan and have direct energy conservation benefits.

b. Technical Assessment. Table 2 shows a composite presentation of all other fluids related project synopses appearing in Appendix A. Each project has been rated against five energy objectives using the preliminary numerical system introduced previously. The scheme allocates the numerical rating based on the relevance of the project to the Army Mobility Energy R&D Plan including considered judgement as to the probability of meeting the target

TABLE 2. OTHER FLUIDS EVALUATION

REQUIREMENT	PROJECT Long Life Coolants	Use of Recycled Oils
DA GOAL/OBJECTIVE	023	026
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X	X
Improve Engine Efficiency		
Increase Simulators		
2a. (1) Develop capability to use synthetic/alternate fuels		
Multifuel Engines		
Shale Oil Products		
Unconventional Liquid Fuels		
Transition/Specs		
2a. (2) Increase efficiency of Mobility Systems by 15%		
3. Position of Leadership in pursuit of National Goals		X
SPECIAL INTEREST		
DA		
DOD		
Assessment/Energy Relevance	2	2

goal by the time specified. It does not make judgement as to whether the project meets specified Army requirements or whether the project is technically sound. Only ongoing projects as of August 1979 are considered.

This area of R&D will probably have minimal impact on the overall Army energy picture. In reviewing existing projects, the goals are unquestionably important for improved combat readiness, maintenance upgrading, environmental impacts, economic gains from reduced supply procurements, and supply availability. Likewise these projects must address present product reformulations needs if and when new fuel compositions enter the supply system. This need has already been indicated from alcohol/gasoline lubricant research.

Some energy conservation will be noted from projects such as the re-refined lubricant studies and possibly from new lubricant developments in which the base fluids could be produced from renewable resources, not petroleum crudes. New lubricants which reduce engine friction and thus decrease engine fuel consumption also have potentials. Regardless of these energy conservation potential, their overall energy savings may be difficult to justify solely on the Army's energy goals. It would appear much more viable to incorporate most of the lubricant programs as a needed phase of new fuel-engine development rather than as single programs.

Engines

a. Background/Current Programs. Mobile engines/powerplants consume an estimated 16.4 percent of the Army's total fuel requirement (see figure 13). Technical programs related to engines encompass all military powerplant systems from aircraft to small electric power generator engines which, based on their end application, are the responsibility of different Army R&D commands. Therefore, this section is subdivided into: (1) ground vehicle engines/TARADCOM, (2) aviation engines/AVRADCOM, and (3) mobile electric power engines/MERADCOM.

FY77 MOBILITY FUEL CONSUMPTION

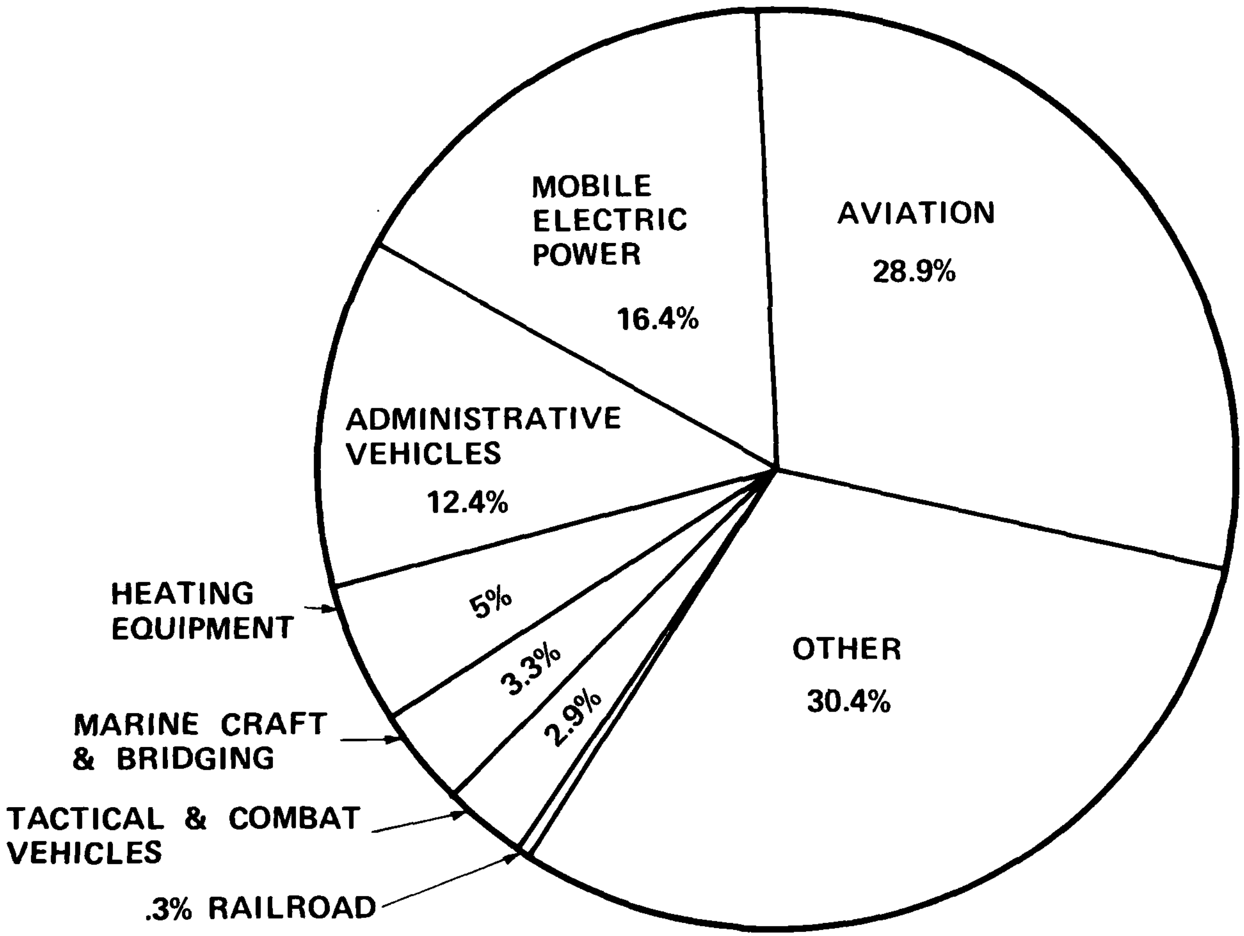


FIGURE 13

(1) Ground Vehicle Engines - TARADCOM. The US Army Tank-Automotive Research and Development Command has the overall mission of development of tactical and combat ground vehicles for the US Army. It is also the engine developer for the Army for tank/automotive equipment. The military has long held a special interest in multifuel engines with wide fuel tolerance. A ground fleet of vehicles with wide fuel tolerance provides for flexible operation in the field under conditions where fuel supply is difficult.

During the period from 1955-1960, the Army ordnance Corps and Army Tank-Automotive command initiated design and procurement contracts for a military vehicle multifuel engine designated LDS-427. A follow-on to this engine was an upgraded design version designated LDLDS-465 multifuel engine which is still in volume use as the powerplant for 2.5- and 5-ton tactical cargo vehicles. In the early 1970's, governmental policies specified that future Army ground vehicle engines below 500 hp be procured from commercial sources and that R&D on this lower horsepower family be curtailed. Therefore, the major engine design thrusts funded by TARADCOM are directed at combat vehicles requiring 500+ hp powerplants. The high mobility multipurpose wheeled vehicle, light will produce a 20% improvement over 1/4 -- 1-1/4 weight class vehicles. The first production is scheduled for 1983 if the program is approved.

Military tactical and combat vehicle fuel requirements represent an estimated 0.2 to 5 percent of the total Army fuel requirement of which 85 percent is consumed by wheeled tactical vehicles in the 1/4- to 5-ton weight class. The remaining 15 percent is consumed by combat vehicles. Challenges facing the engine R&D community include: (1) seeking ways of desensitizing engines to fuel quality, and (2) increasing overall engine energy utilization efficiency while maintaining equipment combat mobility effectiveness.

There has been an emphasis in the past to develop ground vehicle engines with a wide fuel tolerance and TRADCOM has been highly successful in this effort. A review is presented here of some of TRADCOM's current engines which have been developed for operation on a wide range of petroleum fuels. These include the AGT-1500 turbines for the XM1 tank, the 10KW APU being developed by TARADCOM for the XM1 tank, the LD 465 series multifuel diesel engines for 2½ and 5 ton trucks and recent efforts to develop the LIS 163-S stratified charge multifuel engine for the M151 jeep. A review is also presented of current technology development applicable to present tank engines and that will have an impact on fuel tolerance of engines of the future.

Current engine research efforts are also described which have their primary emphasis on advanced development of the adiabatic diesel and advanced turbine engines. As a new emphasis, engines will be developed which have multifuel capability and can burn the new alternate fuels that are starting to be produced in this country. New technology developments will make significant contributions in continued progress toward high output engines with widening fuel tolerance for the future. Engine development for alternate fuels for Army ground vehicles past work and future efforts of TARADCOM is described in the following subparagraphs:

(a) Engines for Alternate Fuels -- The Need. The very basis of defense depends on a guaranteed energy supply particularly in the forms of liquid hydrocarbon fuels. Energy alternatives are needed that are domestically controllable and engines must be developed for operation on these fuels. The Department of Defense has committed itself to a long range program to provide for assured fuels to maintain readiness of Military Forces. Within the Department of Defense there will be new thrusts to assist in establishment

and support of a commercial synthetic fuels industry within America. The DOD Engines/Fuel technology program will be accelerated and efforts will be made to establish synthetic fuel specifications for the military for the future. There will be new emphasis to develop engine systems capable of burning a broad range of new synthetic and commercial fuels which can be produced and are available in America. It is in this engine development for alternate fuels area that TARADCOM will be active. The definition used at TARADCOM to describe multifuel engines capable of burning alternate fuels is shown below:

> A multifuel engine is one with the ability to operate on a wide range of hydrocarbon fuels (from gasoline to diesel, including shale oil or coal derived fuels, with a wide spread of octane and cetane tolerance) in military vehicles without requiring physical adjustment or compromising engine performance or life.

(b) Present Wide Fuel Tolerant Engines. In this discussion it will be shown how present engines fit this definition and how some will need further development in order that fuels of varying octane-cetane ratings, viscosity and specific gravity can be used. Engines developed by TARADCOM with potentially good multifuel characteristics are as follows:

1. AGT 1500 Turbine developed by TRADCOM with Lycoming for XM1 Main Battle Tank (Fuels are DF-2, DF-1, DF-A, JP-4, JP-5; Gasoline and Marine Diesel in Emergency).

2. 10KW APU using the Solar Gemini Turbine for XM1 Main Battle Tank (Fuels same as for AGT 1500).

3. LD 465 Multifuel Diesel Engines for Army 2-1/2 and 5 ton trucks (Fuels are DF-M, DF-2, DF-1, JP-4, JP-5, JP-6, JP-8, JET-A-1, JET A-2, Burner Fuel Oils No. 1 and No. 2 and Combat Gasoline).

4. LIS-163-S Stratified Charge Engine Using the Texaco Combustion System; developed for TARADCOM by White Motor Company for use in the M151 1/4-ton Jeep (Fuels are DF-2, DF-1, and Combat Gasoline).

(c) The AGT 1500 Turbine. The AGT 1500 turbine operates at a gross output power of 1500. Its physical dimensions provide a tank engine of small size and weight (47.6 cu. ft. /2500 lbs). The AGT 1500 is currently developed with mutlifuel capability and has been the topic of much of the current research effort on turbine fuel tolerance. This engine operates on a wide range of jet and diesel fuels without reduction in performance because of the fuel control system which controls fuel supply to limit turbine inlet temperature. TARADCOM advanced multifuel development resulted in the following accomplishments for the AGT 1500 turbine:

1. Optimized air blast fuel injector with pilot injection for ignition.

2. Final combustion design with improved swirler and engine testing.

The XM1 Project Manager's Office provided for the full scale engineering development and complete qualification of the engine for use of DF-2 fuel.

(d) The 10 KW APU for the XM1 Main Battle Tank. The 10 KW APU being developed by TARADCOM for the XM1 tank is a small and lightweight multifuel unit. It is designed to provide cold-starting of the main turbine and to provide for standby electric power requirements. This unit incorporates the Solar Corporation Gemini Turbine which was originally developed for MERADCOM. The APU turbine is being developed to be compatible with all the fuel requirements of the XM1 tank. The APU turbine/electrical generator section will weigh 78 lbs. Additional modules are used to provide for power conditioning, power regulation and remote control. A nickel-cadmium battery kit will be used to provide the electrical power requirement for starting to meet the low

temperature starting requirement. The generator set will provide 10 KW of DC electrical power and is rated at 28 volts DC.

(e) The LD 465 Series Multifuel Truck Engines. The LD series multifuel truck engines have a wide range of application in military trucks from 2-1/2 ton to 5 tons. Approximately 225,000 of these engines have been manufactured since 1962 in naturally aspirated and turbocharged versions with a horsepower range from 125 to 195. These engines have a wide range of fuels which can be employed from diesel to combat gasoline. This engine is limited in use of fuels with a maximum octane rating of 89 RON (corresponding to a cetane rating of 17). It employs a manifold flame heater system for starting and provides for varying fuel injection quantity based on a density compensator which varies fuel delivery with density of the fuel to maintain power delivered.

The M.A.N. combustion system is employed in these engines. This combustion system employs an air intake passage shaped to produce high swirl. Near the top of the compression stroke fuel is injected. Most of the fuel (approximately 95 percent) is deposited as a thin film on the walls of the spherical combustion chamber, in the head of the piston. After ignition of fuel in the chamber the main portion of the charge is progressively vaporized and swept off the combustion chamber walls by high velocity air swirl. The air swirl continues to remove only the upper surface of the deposited fuel thus maintaining even combustion. The combustion system thus provides for smooth combustion for a wide variety of fuels.

(f) LIS 163-2 Stratified Charge Engine. Another TARADCOM [illegible] program with excellent fuel tolerance is the LIS 163-2 [illegible] which was recently developed as a drop in replacement [illegible] 1/4-ton Jeep. The LIS 163-S stratified

charge engine was optimized for operation on diesel fuel but provides excellent fuel economy and provides multifuel capability for operation on gasoline and diesel fuels. It provides for diesel fuel economy which is especially interesting at part load conditions. This engine development was carried on with the White Motor Company employing the Texaco Controlled Combustion System (TCCS). This engine does not have density compensation.

(g) Tank Engines.

1. AVDS 1970 Diesel Tank Engine - 750 Gross HP. The AVDS 1790 Diesel is the current engine used in the M60 Main Battle Tank. This engine is an air cooled engine developed for TARADCOM and is produced by Teledyne Continental Motors. The present tank engine has been developed to operate on DF-2, DF-1 or DF-A fuels. It is not designed as a wide fuel tolerant engine. It employs a manifold flame heater system to provide for ease in starting at low temperatures.

2. AVCR 1360 Advanced Diesel Engine - 1500 Gross HP. The AVCR 1360 is TRADCOM's advanced diesel engine orginally developed as a prototype for the XM1 Main Battle Tank. Development of this engine is presently being continued as a back-up tank diesel engine. A comparison of engine characteristics of the AVDS 1790 current tank diesel engine and the AVCR 1360 are as follows:

Engine	AVDS 1790	AVCR 1360
Rated HP (Gross)	750	1500
Rated Speed (RPM)	2400	2600
BMEP @ Rated Output	277	336
Physical Characteristics		
Length (in.)	68	73
Width (in.)	58	60
Height (in.)	47	45-3/4
Vol. (cu. ft.)	104	107
Engine Wt. Wet (lbs.)	5424	4730

Of interest is the AVCR 1360 engine has a horsepower rating twice that of the 1790 current tank engine and achieves this power with approximately the same volume and less weight. The primary difference contributing to increased specific power is the use of the Variable Compression Radio (VCR) piston in the AVCR 1360 engine.

In the VCR engine a compression ratio of 16.5 is used at light loads and compression ratio of 9 is at heavy load conditions.

The VCR system allows for development of higher BMEP while limited mechanical loading of the engine. Details of the variable compression ratio diesel engine are given in SAE Report 760051, Feb. 1976, "AVCR 1360-2 High Specific Output Variable Compression Ratio Diesel Engine".

(h) Multifuel System Development for Tank Engines. A recent effort has been made by TARADCOM to develop a system for increasing the multifuel capability applicable to both the existing and advanced military diesel engines and to determine the range of fuels that can be successfully used. The approach used in this study was to provide a manifold heating system to vary mainfold temperatures as a function of the fuel cetane number. Manifold temperature regulation was provided to limit maximum rate of pressure rise to acceptable limits. Fuel delivery to the mainfold flame heater was regulated by an electronic control system. A fuel density compensator was employed to provide an indication of fuel density (related to cetane number) to the electronic controller. The fuel nozzle used in the engine testing in this program was a Robert Bosch commercially available, electronically controlled, solenoid activated fuel injection nozzle. The nozzle was pulsed every 20 milliseconds with total flow varied by controlling length of time of pulse. This program provided a demonstration of automatic operation of our present tank engine

with controlled combustion on widely varying fuels. Further refinement of this system is required to provide better manifold air temperature distribution.

Fuels with lower cetane ratings (requiring higher manifold temperatures) resulted in reduced brake horsepower. Brake specific fuel consumption also increased since fuel supply included both engine fuel and manifold heater fuel.

Addition of a fuel density compensator into the fuel injection pump of this engine will also make possible constant fuel flows on a weight basis with lower density fuels and thus reduce the power loss experienced.

(i) TRADCOM Diesel Advanced Technology Program. In recent years TARADCOM has actively pursued several areas of advanced diesel technology primarily aimed at producing higher output engines with improved fuel economy, reduced weight and greater compactness. Efforts in this area include work on variable area turbocharging, turbocompounding and electronic fuel injection.

<u>1</u>. <u>Variable Area Turbocharging (VAT)</u>. The variable area turbocharger is currently being used with the AVCR 1360 engine to provide higher output with an improved torque characteristic. The VAT is being employed at a 4.8 pressure ratio with 16 to 1 peak compression ratio of the VCR piston and 9 to 1 compression ratio at high output.

<u>2</u>. <u>Turbocompounding</u>. A turbocompound system has also been developed for the AVCR 1360 engine to provide for improving power and fuel economy. This system makes use of a power turbine geared to the engine crankshaft. Turbocompounding results in conversion of exhaust energy to mechanical work which is geared back to the main engine output shaft. Two variable area turbochargers are also employed (one for each bank of the 12 cylinder Vee engine).

3. Electronic Fuel Injection System. TARADCOM is currently working with Physics International on an electronic fuel injection system for large diesel engines. Fuel economy benefits can be derived by proper injection control with several combustion related benefits. These include capability of design for wider fuel tolerance, lower cylinder peak pressures, reduced smoke, reduced noise, and reduced exhaust gas temperature. It is expected that advanced electronic fuel injection will provide increased low end torque, improved transient response and improved startability. It is believed that electronic fuel injection will assist in achieving diesel engines for the future with wider fuel tolerance. TARADCOM has been working in the area of advanced high delivery fuel injection systems for several years.

(j) Divided Chamber Multifuel Combustion System. Another combustion system of interest for future multifuel engines is the precombustion chamber type using a flow-plug for cold starting. This combustion system provides for injection and partial burning of the fuel in the precombustion chamber. After ignition the partially burned fuel and products of combustion are expelled from the hot chamber into the main cylinder where combustion is completed. One advantage of this system is that peak pressures of combustion measured in the precombustion chamber are moderated and reduced in the main combustion chamber. This combustion system is very adaptable for development of multifuel engines since the hot chamber provides for better combustion of more difficult fuels.

TARADCOM carried through research and advanced development programs with Caterpillar for a family of engines of 4 and 6 cylinder in line engines and 8 and 12 Vee type engines.

The 12 cylinder supercharged/intercooled engine was developed for 960 horsepower with 1050 cubic inches of displacement. This engine family was referred to as the very high output engine (VHO). It was

optimized for use as a diesel engine on DF-2 using a 16.5 to 1 compression ratio. Earlier development showed that 19.5 to 1 compression ratio was needed to make this engine a multifuel engine capable of burning gasoline, jet and diesel fuels.

One important benefit of developing a family of multifuel engines is that a wide range of power requirements can be accomplished with high interchangeability of parts which simplifies spare parts logistics requirements.

(k) TRADCOM Combustion Research Program. An important contribution to the development of multifuel engine families will come from single cylinder combustion research with the variety of fuels of interest for the future. TARADCOM has been active in the past and will continue an active combustion research program in piston and turbine engines.

The recent turbine engine combustion research of TARADCOM has been primarily directed toward advanced development of the AGT 1500 turbine at Lycoming. Of interest has been improvement for fuel tolerance, reduced smoke, improved starting and improving stability of combustion. TARADCOM has also supported a turbine combustion modeling effort at Purdue.

An important effort to aid in understanding combustion in piston engines was the development of the TARADCOM Single Cylinder Research Engine. This engine was developed for TARADCOM by IHC to provide an investigation tool for use in research studies in high output and high speed ranges typical of the military diesel engine.

The TARADCOM single cylinder research engine has been developed and operated near 400 BMEP with a design limit up to 600 BMEP at engine speeds up to 3000 RPM. Several of these single cylinder engines were

obtained and they have been widely used at TARADCOM, at universities, and in industry in support of the advanced combustion engineering program at TRADCOM.

TARADCOM is also interested in the future of effects of octane/cetane relationship, viscosity, density, cycle effect of ignition delay and fuel injection system characteristics.

(1) TARADCOM Adiabatic Diesel Engine Development. TARADCOM's primary R&D effort in developing diesel engines for the future is the Adiabatic Diesel Engine Program. This engine is being developed in a cooperative program with the Cummins Engine Company. The Adiabatic Engine is a turbocharged reciprocating engine with a second stage turbine geared to the crankshaft. The engine is insulated in the piston and cylinder combustion area, and the exhaust passage is insulated to provide for maximum conservation of exhaust energy to the turbocharger and power turbine. The only cooling provided is engine oil cooling of the underside of piston and cylinder area.

At present, a first stage feasibility engine has been developed to demonstrate high temperature adiabatic technology using the Cummins NHC 250 engine. The adiabatic demonstrator engine involved using a commercial water-cooled block, draining the water, insulating the combustion chamber, using high temperature components, and using a turbocompound system to convert waste energy to useful power. The piston used is a composite using a ceramic cap/high temperature metal fastener/metal base combination. The cylinder liner used is also a composite with ceramic above the top ring reversal position and metal below.

The cylinder head, exhaust valves and exhaustports are also insulated with ceramic composite materials.

It is expected that a considerable amount of design and basic material technology development will be involved in developing the high output adiabatic engine for the future.

Benefits in adiabatic operation of engines will be improved fuel economy by conversion of waste exhaust energy, increased specific power output, elimination or reduction of external cooling system and reduced volume and weight of overall power system.

It is also expected that the high temperature of combustion with hotter combustion chamber parts will assist in the development of multifuel capability for the future.

(m) Future Engine Research and Development. In summary the US Army is presently supporting development of both the adiabatic diesel engines and advanced turbine engines.

New technology will make significant contributions toward higher output and higher economy engines with widening fuel tolerance for the future.

TARADCOM will be working on developing engines for the future which have (1) multifuel capability and (2) can burn the new alternate fuels that are starting to be produced in this country. TARADCOM is interested in developing the required power systems for the future with engines of good power density and good fuel economy for combat vehicle application at an acceptable cost.

Immediate programs will include efforts to initiate development of new technology and components for multifuel engines. Some of TARADCOM's current engines will be modified to develop them to higher levels of fuel tolerance. TRADCOM will be working within the Department of the Army and Department of Defense to define the fuel requirements and assist in establishing

the ultimate specifications for alternate fuels required. The determination of required funding will be a very important part of this effort.

TARADCOM will initiate the necessary research and development as required for the future engines for Army ground vehicles.

(2) Aviation Engines - AVRADCOM. The Army aviation aircraft inventory has continued to increase over the past 20 years with the introduction of the helicopter as an essential member of the combined arms concept. Compared to ground piston powerplants, aircraft turbine engines are more fuel demanding from both the standpoint of consumption, and reduction of hardware fuel sensitivity. To decrease fuel consumption, programs such as, (1) higher turbine inlet temperature capabilities; (2) recuperation of exhaust waste heat; and (3) improved internal aerodynamics, stress technology in hardware materials, and combustion processes. Changes of fuel properties, i.e., increased sulfur, higher aromatics, and increased viscosity add further requirements on turbine materials, combustor design, and peripheral fuel systems. As noted earlier, the USAF has lead service responsibility for aviation fuel development. Therefore, AVRADCOM as a major aviation developer must interface very closely with USAF (and USN aviation) to ensure Army/DOD energy goals are achieved in a timely manner.

It is estimated that the Army aviation sector utilizes approximately 16.4 percent of the Army's fuel demand (figure 13). This represents a significant part of the Army's fuel demand and, in addition, this fuel represents an important narrow fraction of the hydrocarbon crude already stressed by commercial and general aviation energy demands.

(3) Mobile Electric Power - MERADCOM. Electrical power generation equipment in support of military operations range in size from 0.5 to 1500 KW. Over this broad spectrum, the existing equipment inventory includes diesel and

spark igniton engines, gas turbines, and fuel cells technology. These technology areas have potential for using non-petroleum fuels. Specifically, the development of 10 to 60 KW gas turbine engines has included the capability to operate on a broad range of military logistic fuels including gasoline, turbine engine fuel, and diesel fuel. Current R&D programs address the sensitivity of existing reciprocating engine and gas turbines to fuel quality. These programs also address potential multifuel limitations as well as methods to increase power rating and improve fuel economy. Mobile electric power generation equipment consumes an estimated 16.4 percent of the fuel used by the Army and provides an essential support element in mobile weapon systems, logistics activities, and communications.

b. Technical Assessment. Table 3 is a composite presentation of all engine-related project synopses appearing in Appendix A.

A major R&D gap appears in the area of multifuel engine development. As previously stated in this planning document, TARADCOM, by DA policy, which has been ongoing since the middle 1960, cannot conduct R & D in this area. Therefore, it is questionable whether or not major multifuel engine design, development, and production can be realized by 1985, unless a massive program effort is initiated. It does not appear reasonable to believe that commercial engine design changes, through 1985, will satisfy the Army's broad fuel tolerance needs and therefore permit the MACI program to satisfy this Army goal. The below 500-hp engine area is where most of the fuel consumption occurs for mobile ground vehicles.

As stated in the Fuels section (1)(c), aviation turbine engine fuel requirements, based on existing new engine design projects, must be identified to assure fuel-hardware compatibility. These requirements most likely will not be the same for the Air Force and Army aviation. This area appears

TABLE 3. ENGINES EVALUATION

REQUIREMENT	PROJECT Adiabatic Diesel Engine	Engine Concepts for Alternate Fuels	AGT-1500 Fuel Economy Program	Turbine Engine Combustion Research	Advanced Turbine Component Research	Advanced 1000 HP Diesel Engine	Improved Helicopter Engine	Variable Capacity Engine	Advanced Heat Engines
DA GOAL/OBJECTIVE	001	002	004	007	008	010	017	018	021
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X		X						
Improve Engine Efficiency	X		X	X					
Increase Simulators									
2a. (1) Develop capability to use synthetic/alternate fuels		X		X			X	X	X
Multifuel Engines				X					
Shale Oil Products									
Unconventional Liquid Fuels		X							
Transition/Specs									
2a. (2) Increase efficiency of Mobility Systems by 15%					X	X	X	X	X
3. *Position of Leadership in pursuit of National Goals*									
SPECIAL INTEREST									
DA	X	X	X						
DOD		X							
Assessment/Energy Relevance	4	5	3	3	4	3	5	3	4

TABLE 3. ENGINES EVALUATION - Continued

REQUIREMENT	PROJECT Engine Combustion Research	Develop Multifuel Engines (TAC/COMBAT)	Multisource Fuel Engine for Aircraft	Alternate/Multifuel Engines for MEP
DA GOAL/OBJECTIVE	075	076	077	078
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)				
Improve Engine Efficiency				
Increase Simulators				
2a. (1) Develop capability to use synthetic/alternate fuels	X	X	X	X
Multifuel Engines		X	X	X
Shale Oil Products				
Unconventional Liquid Fuels				
Transition/Specs				
2a. (2) Increase efficiency of Mobility Systems by 15%	X			
3. Position of Leadership in pursuit of National Goals				
SPECIAL INTEREST				
DA		X	X	X
DOD		X	X	X
Assessment/Energy Relevance	+*	4	5	4

extremely critical to the transition to syncrude-produced fuels unless all new fuels will meet existing DOD specsifications. Turbine combustor R&D programs, if fully implemented, may have a significant effect on the Army's total mobile engergy needs and thus warrent increased emphasis.

Another potential for saving petroleum energy exists if fuel cell technology can be advanced rapidly for use as the power system for mobile generator equipment. This technology could impact on hydrocarbon fuel consumption and conversion to renewable energy resources. Such technology may also be applied to other power systems once the full technology potential is evaluated.

Other Equipment

a. Background. It is estimated that 2- to 3-percent of the Army total energy consumption is required to satisfy needs of field heaters, cook stoves, material-handling equipment (forklifts, cranes, etc.), railroad locomotives, bridging equipment, and other combat service support items. This energy requirement, though diffused among a broad spectrum of equipment, represents a total fuel demand equal to yearly tactical/combat vehicle consumption. Interaction between future fuel development and these support items is paramount. For example, introduction of synthetic diesel fuel and an intensive dieselization of generators, high mobility multipurpose wheeled vehicles, etc. will require conversion of existing TO&E food preparation stoves from gasoline to middle distillates, and redesign of existing stoves and heaters to handle the lower btu fuel. Some of this equipment redesign is underway.

Material-handling equipment is procured primarily from commercial companies under the MACI program. Introduction of new fuels or development of multifuel engines may impact on this equipment, especially if the Department of the Army is not permitted by policy to carry out R&D on these end items because of MACI procurement. Likewise, fuel cell development and DOD/DOE electric

vehicle R&D may prove valuable in energy/powerplant applications for small tugs and forklifts within major DOD depot operations.

Railroad locomotives owned and operated by the military, presently require specification diesel fuel and are energy-intensive equipment due to limited shutdown periods.

Army fuel-handling equipment necessary for fuel distribution is in this category, and must be compatible with any new fuel compositions. Material development for fuel hoses, fuel storage bladders, fuel vapor controls for reducing in-field fuel losses, and different filters could be demanded as new fuels enter the military supply system.

Though these support type items do not have the high visibility of combat vehicles or aircraft, they do represent the logistics system which provides petroleum and all other supplies to the combat arms. Therefore, each facet of the supply system, from procurement to delivery, will be affected as new energy sources become available to the ground and aviation sectors.

b. Current Programs. The technical programs in this area cover a diverse range of equipment. The projects can be divided into the following categories:

(1) Other power sources.

(2) Simulators.

(3) Material technology.

(4) Combat and tactical vehicle components.

(5) Food technology.

(6) Miscellaneous.

(7) Missile manufacturing energy conservation.

The thrust of this program area is oriented to conservation and improved efficiency to meet the Army's energy goals. Alternative approaches

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(5) Food technology.

(6) Miscellaneous.

(7) Missile manufacturing energy conservation.

The thrust of this program area is oriented to conservation and improved efficiency to meet the Army's energy goals. Alternative approaches

to performing the Army's mission through use of simulators or use of alternate energy power sources are highlighted in reducing petroleum consumption. The programs in this area are the responsibility of different R&D Commands. Most of the programs are being performed for other than energy-related reasons.

(1) Other power sources area is related fuel cell work, improvements in efficiency of the mobile electric power plant equipment, development of improved and hand cranked generator technology and R&D to improve primary and secondary batteries for for Army equipment. These programs are listed in Appendix A.

(2) Simulator area covers programs to reduce fuel consumption in the bridging, artillery, and air drop modeling of equipment. It has a major role to play in training and offers a great potential for energy conservation. Simulator programs are listed in Appendix A.

(3) Material technology area provides programs to develop lightweight vehicles and high temperature materials to reduce vehicle weight and allow high temperature engine operation, respectively, which results in high energy efficiency. Heat energy previously dissipated is recovered for useful work. Programs in material technology appear in Appendix A.

(4) Combat and tactical vehicle components area provides projects to improve transmission efficiency, evaluate radial tires to reduce fuel consumption, adapt and adopt easily procurable commercial items to military use. Programs in this area are included in the MACI projects, the materials technology projects and the other power sources projects.

(5) Food technology area conducts programs and projects designed to improve energy efficiency in food preparation, transportation, and serving. Technolo[illegible] programs in this area appear in Appendix A.

(6) Miscellaneous area provides projects to improve energy efficiency of Army watercraft, construction equipment, field oven/griddle, mobile laundry, and environmental control equipment and test equipment for I.C. engines. Projects have been formulated for decreasing the energy consumption in the manufacturing and firing of missiles through the development of improved engines and material.

(7) Missile manufacturing energy conservation is related to saving energy in the manufacture of missiles and related components.

c. Technical Assessment. Table 4 is a composite presentation of other equipment-related project synopses appearing in Appendix A.

Simulators provide the greatest energy-saving potential within this large, all-encompassing area. All other ongoing projects will add some small energy conservation effect but may be less visible when the total Army energy needs are evaluated. It should be stressed that most projects in this area consider equipment that must function on fuels used by ground vehicles; therefore, air conditioners, heaters, cook stoves, etc. must have projects identified which function parallel to engine-fuel programs. Existing project synopses do not appear to address this area except in cook stove burner design.

Non-RDT&E Projects

The technical programs in this area also cover a wide range of effort which, although not considered RDT&E, support RDT&E. Table 5 is a composite presentation of these efforts (e.g., MACI, PIP, and MMT activities).

A description is included in Appendix E.

TABLE 4. OTHER EQUIPMENT

REQUIREMENT	PROJECT Fuel Cell Power Plants	Efficient Mobile Electric Power Systems	Samarium-cobalt Generator Technology	Training Simulator for Bridging	Airdrop Simulation	Training Device for Artillery Crews	Advanced Composite Materials & Structures	Radiation Preservation of Food	Efficient Oven and Griddle
DA GOAL/OBJECTIVE	019	020	049	034	043	053	003	036	038
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)				X	X	X	X	X	X
Improve Engine Efficiency									
Increase Simulators									
2a. (1) Develop capability to use synthetic/alternate fuels	X		X						
Multifuel Engines									
Shale Oil Products									
Unconventional Liquid Fuels	X								
Transition/Specs									
2a. (2) Increase efficiency of Mobility Systems by 15%		X	X						
3. Position of Leadership in pursuit of National Goals									
SPECIAL INTEREST									
DA	X			X	X	X			
DOD	X			X	X	X			
Assessment/Energy Relevance	5	3	3	2	2	4	2	2	1

TABLE 4. OTHER EQUIPMENT - Continued

REQUIREMENT / PROJECT	Advanced Hydro-Mechanical Transmissions	Test Equipment for I.C. Engines	Efficient Environmental Control Equipment	Efficient Army Watercraft	Composite Structural Vehicle Components	Ceramic Component Technology	Heat Engine Vehicle Systems Materials	Missile Manufacturing Energy Conservation*
DA GOAL/OBJECTIVE	011	016	022	035	044	046	047	
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X	X						
Improve Engine Efficiency		X		X			X	
Increase Simulators								
2a. (1) Develop capability to use synthetic/alternate fuels								
Multifuel Engines								
Shale Oil Products								
Unconventional Liquid Fuels								
Transition/Specs								
2a. (2) Increase efficiency of Mobility Systems by 15%	X	X	X	X	X	X	X	
3. *Position of Leadership in pursuit of National Goals*								
SPECIAL INTEREST								
DA								
DOD								
Assessment/Energy Relevance	3	2	3	2	2	4	3	

*Not evaluation as part of the mobility energy R&D Plan. Will be integrated into Facilities Section

TABLE 5. NON-RDTE

REQUIREMENT / PROJECT	Non-Petroleum Based Hydraulic Fluids (1)	Hybrid Fuel Cell for MHE (1)	Analysis of Radial vs. Bias Tires (1)	Electric Vehicle Evaluation (1)	Comparative Analysis of MHE (1)	MACI Engine Program (1)	Efficient Mobile Laundry Equipment (2)	Efficient Army Watercraft (2)	M113 PIP (2)
DA GOAL/OBJECTIVE	032	033	013	014	031	012	039	035	6
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X		X		X	X			X
Improve Engine Efficiency			X						
Increase Simulators									
2a. (1) Develop capability to use synthetic/alternate fuels	X	X		X					
Multifuel Engines									
Shale Oil Products									
Unconventional Liquid Fuels		X		X					
Transition/Specs									
2a. (2) Increase efficiency of Mobility Systems by 15%			X		X	X	X	X	X
3. *Position of Leadership* in pursuit of National Goals	X	X			X				
SPECIAL INTEREST									
DA									
DOD									
Assessment/Energy Relevance	1	3	2	4	3			2	1

1. MACI
2. PIP
3. MMT

TABLE 5. NON-RDTE - Continued

REQUIREMENT / PROJECT	Transmission and transfer Assemblies (1)	Commercial Power Sources for Combat Engines (1)	Commercial Trucks for Tactical Use (1)	Kocite® Electrodes for Fuel Cells (3)	High Temperature (3) Nozzle for Turbines	Molten Salt Li/Cl Batteries (3)	Integrated Power Switch (3)	Ceramic Gas Path Seal (3)
DA GOAL/OBJECTIVE	15							
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X	X		X	X	X	X	X
Improve Engine Efficiency								
Increase Simulators								
2a. (1) Develop capability to use synthetic/alternate fuels								
Multifuel Engines								
Shale Oil Products								
Unconventional Liquid Fuels				X		X		
Transition/Specs								
2a. (2) Increase efficiency of Mobility Systems by 15%	X	X		X	X		X	X
3. Position of Leadership in pursuit of National Goals								
SPECIAL INTEREST								
DA								
DOD								
Assessment/Energy Relevance								

TABLE 5. NON-RDTE - Continued

REQUIREMENT	PROJECT: Light Weight Hood & Fenders (3)	Fabrication Techniques for Ceramics (3)
DA GOAL/OBJECTIVE		
1a. Reduce Consumption by 10% (1985) Zero Growth (2000)	X	X
Improve Engine Efficiency		
Increase Simulators		
2a. (1) Develop capability to use synthetic/alternate fuels		
Multifuel Engines		
Shale Oil Products		
Unconventional Liquid Fuels		
Transition/Specs		
2a. (2) Increase efficiency of Mobility Systems by 15%	X	X
3. Position of Leadership in pursuit of National Goals		
SPECIAL INTEREST		
DA		
DOD		
Assessment/Energy Relevance		

SECTION 4. MANAGEMENT PLAN

Management for any project or program in the Army Mobility Energy R&D Plan will remain with the appropriate development command, and they are expected to present these programs/projects at the DA/DARCOM reviews for funding and approval. Programs/projects should be clearly identified as an energy effort contained in the plan. Additionally, MERADCOM will accomplish the following:

a. The update of the Army Mobility Energy R&D section of the plan.

b. The coordination and monitoring necessary to do the update, respond to DARCOM/DA/DOD queries of a general nature, and ensure compatibility and non-duplication with the other services, DOE, and other government agencies.

c. The development of an "assessment" methodology to define system performance and evaluation, develop the necessary data base, ensure technology transfer (of a general nature), and provide user assistance.

ARMY MOBILITY ENERGY ASSESSMENT FUNCTION

The assessment function will be responsible for conducting the following major tasks:

a. Needs Analysis - Examine Army Mobility Energy uses and needs for both peacetime and wartime.

b. Data Base - With technology element develop a data base on energy technology including operational experience.

c. Methodology - Acquire, modify or develop methodology, including computer codes/simulation to conduct:

(1) Trade-off analyses.

(2) Life cycle costing.

(3) RAM analysis.

(4) Effectiveness analysis.

d. Categorization - Categorize Army Mobility energy use and needs into logical groupings.

e. System Engineering/Integration - Develop System Engineering/ Integration plans and documentation including handling or storage systems for any new liquid or gaseous fuels.

f. Recommendations - Provide results and recommendations for (1) technology base effort; (2) test and evaluation planning; (3) conservation; (4) system design; and (5) evaluation/application of existing or commercially developed energy technology.

TECHNOLOGY BASE AND TRANSFER

This multifaceted effort will consist of advanced technology R&D, monitoring of commercial and other government R&D work, and management and/or coordination of energy or energy related work within the Army. The basic tasks of this effort are to (1) develop a technology R&D plan and program; (2) define energy efforts uniquely suited for Army/DOD sponsored R&D; (3) define energy efforts suited for DOD/DOE cooperation, and accomplish or manage/coordinate the R&D effort; (4) monitor energy work being accomplished by other government agencies or by industry to apply or adapt the technology as appropriate to Army requirements and needs; and (5) support the System Performance and Evaluation, Application, and user assistance groups.

The technology effort will be structured into reasonable groupings, such as:

a. Fuels and Lubricants (including alternative fuels)

b. Solar - Electric

c. Solar - Thermal

d. Electrical Power and Distribution

e. Conservation

f. Engine/Prime Mover

g. Wind

h. Fuels Handling

i. Energy Storage

A brief summary of the above are as follows:

a. Fuels and Lubricants. This is an ongoing program in the Army. Included in this area is work on fossil fuels, including coal and shale oil derived fuels, synthetic fuels; fire safe fuels; engine oils; power transmission fluids, and corrosion preservatives.

b. Solar-Electric. MERADCOM is currently the DOD lead lab on the joint DOE/DOD solar photovoltaic demonstration project.

c. Solar-Thermal. Solar thermal technology offers much potenital particularly for CONUS post, camp, and stations. There currently is effort in this area by the Corps of Engineers.

d. Electric Power and Distribution. This is ongoing program at MERADCOM in the Electrical Power Laboratory. Included are the DOE generator program (through the Project Manager, Mobile Electric Power), fuel cell development, new engine cycle research, power conditioning, and electric power distribution.

e. Conservation. This is an important area for the Army with the potential for significant energy savings. The area needs considerable expansion beyond the obvious and/or required actions of lowering thermostats, using fewer gallons of fuel each week, and delaying the turn-on of building air conditioning.

f. Engine/Prime Mover. This technology area will be incorporated into the program in three ways: (1) maintaining awareness of development work at TARADCOM and AVRADCOM, and within industry, (2) development of fuels to increase efficiency and performance of conventional engines, and (3) research on new cycles/engine designs.

g. Wind. The thrust in this area is with the development of generators and power conditioners.

h. Fuels Handling. The Army program for fuels handling equipment is at MERADCOM. While this effort continues, the development work towards new fuels (liquid or gas) needs to be monitored and considered in the development effort of fuels handling equipment.

i. Energy Storage. This technology area is concerned primarily with storage other than batteries, such as hydraulic techniques. Battery development, the responsibility of the Electronics Command, should be monitored for interface requirements.

MANAGEMENT/COORDINATION PLAN

A review of the existing energy R&D and related projects indicates that established projects can be used as the means of implementing this proposed R&D mobility energy program. Memoranda of Understanding with DOE in the solar-photovoltaic demonstrations and research on synthetic fuels provide the basis for maintaining and expanding the US Army participation in the National Research and Development effort toward new and improved energy sources. It is necessary that proper program priority and resources be provided to assure the adequate and timely completion of specific R&D tasks.

Coordination of the efforts of this program is required at all levels of DA, DOD, and DOE. This includes technical and funding requirements, and the

establishment of priorities for development, testing, production, and employment. The principal thrust of formal coordination is through the chain of command with appropriate inputs at each command level (See figure 4).

Appendix C lists current cooperative efforts between DOD and DOE. Appendix D lists, for reference, the interagency Advanced Power Groups Briefs.

SECTION 5. RESOURCES

Three major programs were identified as particularly relevant to the Army energy goals and objectives: Alternative Fuels, Fuels and Lubricants, and Engine Development. They are further described in Appendix B.

The FY80, FY81, and FY82 programs for the shale oil derived portion of the alternative fuel program are shown in figures 14, 15, and 16. The funds shown are as of 8 February 1980. The other major effort in the Alternative Fuels Program, Gasohol Evaluation, is shown in figures 17 and 18. The funds shown are as of 8 February 1980.

The funding profiles for recommended Army Engine Development are shown in figure 19 with both funded and unfunded displayed. The funds shown in the figure are as of 27 November 1979.

The process of developing the Army Mobility Energy R&D Plan included requesting and receiving from all DARCOM R&D Commands, recommendations for energy/energy-related projects. Seventy-nine (79) inputs were received. They were subjectively assessed for "energy relevance" and assigned values as shown in figure 2. They are summarized in figures 20, 21, 22, 23, and 24, and are catalogued into the four program areas shown in figure 1. They are further identified as funded or unfunded.

This same funding data is regrouped by DA goal vs RDT&E category, Table 6; by DA goal vs Command, Tables 7, 8, and 9; and by Technical area vs RDT&E category, Table 10.

8 FEB 80

FY80 PROGRAM FOR ALTERNATIVE SYNFUELS-SHALE FUEL RDTE

TASK	AMOUNT $K*	TYPE	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	690	6.2	AFLRL	CONTRACT MOD
FUEL MATRIX STUDY	75	6.2	CONTRACTOR	
COMPATIBILITY:				
MATERIALS	100	6.2	MAT'L TECH LAB	TRANSFER
COMPONENTS, FHE	175	6.2	E&WR LAB	(DRDME-GS)
TOXICITY	150	6.2	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	350	6.2	ELEC PWR LAB	TRANSFER
VEHICLES	300	6.2	TARADCOM/TARCOM	MIPR
AIRCRAFT	100/(3600)	6.2/(6.4)	AVRADCOM	MIPR
LIAISON/COORDINATION	135	6.2	E&WR LAB	
SYSTEMS ANALYSIS	75	6.2	CONTRACTOR	
ACCELERATING QUAL				
METHODOLOGIES	89/(1000)	6.2/(6.3A)	CONTRACTOR	
TOTAL	2,239	6.2		
	(1,000)	(6.3A)		

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THROUGH DOD-DOE MOU. VALUES IN PARENTHESIS ARE UNFUNDED.

Figure 14. FY80 Program Alternative Synthetic Fuels Shale Synfuel Effort

PROGRAM FOR ALTERNATIVE SYNFUELS - SHALE FUEL RDTE

TASK	AMOUNT $K*	TYPE	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	365	6.2	AFLRL	
COMPATIBILITY:				
MATERIALS	125	6.2	IN-HOUSE	
COMPONENTS, FHE	150	6.2	IN-HOUSE	
TOXICITY	200	6.2	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	250	6.2	IN-HOUSE	
VEHICLES	400	6.2	TARADCOM/TARCOM	MIPR
AIRCRAFT	(8000)	(6.4)		
LIAISON/COORDINATION	125	6.2	IN-HOUSE	
ENGINEERING PILOT FIELD TESTS	350	6.2	IN-HOUSE/MIPR	
SYSTEMS ANALYSIS	100	6.2	CONTRACTOR	
ACCELERATING QUAL	100/(1158)	6.2/(6.3A)	CONTRACTOR	
METHODOLOGIES				
TOTAL	2165	6.2		

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THROUGH DOD-DOE MOU. VALUES SHOWN IN PARENTHESIS ARE UNFUNDED.

Figure 15. FY81 Program Alternate Synthetic Fuels Shale Synfuel Effort

8 FEB 80

FY82 PROGRAM FOR ALTERNATIVE SYNFUELS - SHALE & COAL FUELS RDTE

TASK	AMOUNT $K * (SHALE)	(COAL)	ACTIVITY	ACTION REQUIRED
LABORATORY CHARACTERIZATION	200	600	AFLRL	
COMPATIBILITY:				
MATERIALS	100	175	IN-HOUSE	
COMPONENTS, FHE	150	250	IN-HOUSE	
TOXICITY	100	250	AEHA	MIPR
ENGINE ENDURANCE TESTING:				
GROUND SPT EQUIP	250	350	IN-HOUSE	
VEHICLES	350	250	TARADCOM/TARCOM	MIPR
AIRCRAFT	0(6600)	125	AVRADCOM	MIPR
LIAISON/COORDINATION	150	145	IN-HOUSE	
ENGR PILOT FIELD TEST	350	--	IN-HOUSE/MIPR	
SYSTEMS ANALYSIS	150	125	CONTRACTOR	
ACCELERATING QUAL METHODOLOGIES	300	200	CONTRACTOR	
	2100	2470		
TOTAL	4570			

* FUEL PROCUREMENT COSTS NOT INCLUDED AS FUELS TO BE PROVIDED THRU DOD-DOE MOU. VALUES SHOWN IN PARENTHESIS ARE UNFUNDED.

Figure 16. FY82 Program Alternate Synthetic Fuels Shale Synfuel Effort

PLANNED OBLIGATION OF INCREASED FUNDS FOR GASOHOL PROGRAM

TASK	AMOUNT $K	ACTIVITY	ACTION REQUIRED
COMPATIBILITY:			
MATERIALS	100	MAT'L TECH LAB	TRANSFER
COMPONENTS, FHE	45	E&WR LAB	(DRDME-GS)
COORDINATION & LIAISON	70	E&WR LAB	(DRDME-GL)
ENGINE ENDURANCE TESTING:			
GROUND SPT EQUIP	350	ELEC PWR LAB	TRANSFER
VEHICLES	100	AFLRL	CONTRACT MOD
FLEET TESTING[1]			
FORT BELVOIR	75	--------	MIPR
RED RIVER ARMY DEPOT	75	--------	MIPR
LETTERKENNY ARMY DEPOT	75	--------	MIPR
FORT LEWIS	75	--------	MIPR
TOTAL	965		

[1] FUNDING PROVIDES FOR ESTABLISHING BASE PROGRAM MONITOR AND PROCUREMENT OF ALCOHOL

Figure 17. FY80 Program - Gasohol Evaluation

8 FEB 1980

FY81 PROGRAM FOR GASOHOL EVALUATION

TASK	AMOUNT $K[1]	ACTIVITY	ACTION REQUIRED
COMPATIBILITY:			
MATERIALS	100	MAT'L TECH LAB	TRANSFER
COMPONENTS' FHE	75	E&WR LAB	(DRDME-GS)
COORDINATION & LIAISON	75	E&WR LAB	(DRDME-GL)
ENGINE ENDURANCE TESTING:			
GROUND SPT EQUIP	100	ELEC PWR LAB	TRANSFER
VEHICLES	-0-		
FLEET TESTING[2]			
FORT BELVOIR	220	--------	MIPR
RED RIVER ARMY DEPOT	220	--------	MIPR
LETTERKENNY ARMY DEPOT	220	--------	MIPR
FORT LEWIS	220	--------	MIPR
TOTAL	1230		

[1] VALUES SHOWN REFLECT REQUIRED LEVEL OF FUNDS. TO DATE, FY81 PROGRAM IS UNFUNDED.

[2] FUNDING PROVIDES FOR BASE PROGRAM MONITOR COORDINATION ACTIVITIES AND PROCUREMENT OF ALCOHOL/GASOHOL

Figure 18. FY81 Program - Gasohol Evaluation

ARMY ENGINE/HARDWARE RDTE PROGRAMS

	FY80	FY81	FY82	FY83
MERADCOM				
FUNDED	1,780	1,713	630	1,040
UNFUNDED	700	1,500	1,500	2,500
AVRADCOM				
FUNDED	240	1,027	5,906	9,325
UNFUNDED	6,110	21,910	27,319	17,433
TARADCOM				
FUNDED	5,867	7,836	11,783	15,534
UNFUNDED	0	8,052	569	400

AS OF 24 MAR 80

Figure 19

FUELS—FUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
37	ENZYMATIC HYD. OF CELL. MATLS.	NAR	4	6.1	AH52	100	150	150
27	FUEL STABILITY AND TEST DEVELOPMENT	MER	4	6.2	AH20	100	75	100
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.2	AH20	300	2165	430
29	HIGH ENERGY FUELS	MER	3	6.2	AH20	100	75	100
79	GASOHOL EVALUATION	MER	4	6.2	AH20	130	0	0
28	MILITARY FUEL MONITOR	MER	1	6.3	D150	0	0	100
29	HIGH ENERGY FUELS	MER	3	6.3	D150	0	0	200
25	USER ACCEPTANCE TESTING OF FUELS	MER	1	6.3	D150	0	0	350

OTHER FLUIDS—FUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
23	LONG LIFE COOLANT SYSTEM	MER	2	6.2	AH20	100	100	125
26	USE OF RECYCLED OILS	MER	2	6.2	AH20	100	90	50
23	LONG LIFE COOLANT SYSTEM	MER	2	6.3A	D150	0	0	200

Figure 20

ENGINES–FUNDED (AS OF 24 APRIL 80)

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
12	MACI ENGINE PROGRAM	TAR	1	MACI	4301	120	0	0
75	ENGINE COMBUSTION RESEARCH	ARO	+	6.1	BH57	1,119	1,343	1,612
2	ENGINE CONCEPTS FOR ALT. FUELS	TAR	5	6.2	N	0	900	1,000
18	VARIABLE CAPACITY ENGINE	AVR	3	6.2	AH76	190	190	245
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.2	AH76	50	0	0
21	ADVANCED HEAT ENGINES	MER	4	6.2	AH20	130	113	130
46	CERAMIC COMPONENT TECHNOLOGY	AMM	4	6.2	AH84	265	275	300
76	MULTI-FUEL ENGINES FOR TAC/COMB VEHICLES	TAR	5	6.2	AH91	0	900	1,000
8	ADV. TURBINE COMPONENTS	TAR	4	6.2	AH91	314	0	521
21	ADVANCED HEAT ENGINES	MER	4	6.3	DG11	1,650	1,600	500
4	AGT-1500 FUEL ECONOMY PROGRAM	TAR	3	6.3A	DG07	1,606	0	1,650
1	ADIABATIC DIESEL ENGINE	TAR	4	6.3A	N	566	0	6,531
10	ADV 1000 HP DIESEL ENGINE	TAR	3	6.3A	DG07	750	2,600	
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.3A	D447	0	837	5,661
76	MULTI-FUEL ENGINES FOR TAC/COMB VEHICLES	TAR	5	6.3A	DG07	0	0	3,000
1	ADIABATIC DIESEL ENGINE	TAR	4	6.2	AH91	425	600	550

Figure 21

OTHER EQUIPMENT–FUNDED (AS OF 24 APRIL 80)

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
47	HEAT ENGINE VEH. SYST. MATLS.	AMM	3	DOE	DOE	750	0	0
15	TRANSMISSIONS RANSFER ASSEM.	TAR	1	MACI	D607	282	0	0
14	ELECTRIC VEHICLE EVALUATION	TAR	4	MACI	4331	27	27	27
13	RADIAL VS BIAS PLY TIRES	TAR	2	MACI	6003	450	200	0
16	SIMPLIFIED TEST EQUIP. FOR I.C. ENGINES	TAR	2	PAA	D632	9,500	0	0
39	EFFICIENT MOBIL LAUNDRY EQUIP.	NAR	0	PIP	0112	0	125	0
49	SAMARIUM-COBALT GEN. TECH.	HOL	3	6.1	N	100	0	0
19	FUEL CELL POWER PLANTS	MER	5	6.1	AH51	480	320	320
50	ELECTRONIC DEVICES RESEARCH	ERA	0	6.1	AH47	320	310	320
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.1	AH51	120	80	80
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.2	AH20	150	200	114
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.2	AH99	1,020	1,000	750
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.2	AH20	600	530	550
19	FUEL CELL POWER PLANTS	MER	5	6.2	AH20	300	220	270
40	REDUCTION OF FOOD WEIGHT/BULK	NAR	0	6.2	AH99	67	145	135
41	IMPROVEMENT IN FOOD PACKAGING	NAR	0	6.2	AH99	30	0	0
42	THERMOPROCESSED FIELD MEALS	NAR	0	6.2	AH99	200	160	146
43	AIRDROP SIMULATION	NAR	2	6.2	D283	120	200	200
44	COMPOSITE STRUCTURAL VEHICLE COMPS.	AMM	2	6.2	AH84	100	0	0
45	LIGHTWEIGHT SUSPENSION COMPS.	AMM	0	6.2	AH84	300	350	250
49	SAMARIUM-COBALT GEN. TECH.	HOL	3	6.2	N	165	100	0
51	POWER SOURCES FOR ELEC. DEVICES	ERA	0	6.2	AH94	739	650	880
3	ADV. COMPOSITE MATLS/STRUCTURES	TAR	2	6.2	AH91	342	325	275
19	FUEL CELL POWER PLANTS	MER	5	6.3	DG11	394	1,320	2,390
11	ADV. HYDROMECH. TRANSMISSION	TAR	3	6.3A	D395	1,629	2,211	1,906
30	CONTRASTING GROUND COVER	MER	0	6.3A	8201	100	150	150
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.3A	DG11	500	0	0
38	EFFICIENT FIELD OVEN/GRIDDLE	NAR	1	6.3A	DG10	83	120	0
49	SAMARIUM-COBALT GEN. TECH.	HDL	3	6.3A	N	0	250	0
52	ADV TACTICAL POWER SOURCES	ERA	0	6.3A	DG10	861	1,460	1,300
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.4	DL39	500	500	872
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.4	DL47	2,499	2,134	1,060

Figure 22

FUELS—UNFUNDED (AS OF 3 DEC 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.1	AH51	0	0	315
24	ALTERNATE/SYNTHETIC FUELS	MER	5	6.2	AH20	0	0	6,125
29	HIGH ENERGY FUELS	MER	3	6.3	D150	0	150	0
79	GASOHOL EVALUATION	MER	4	6.3A	D150	1,065	1,230	100

OTHER FLUIDS—UNFUNDED (AS OF 15 AUG 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
32	NON-PETROLEUM BASED HYD. FLUIDS	MER	1	MACI	3582	150	200	200

ENGINES—UNFUNDED (AS OF 24 APRIL 80)

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
4	AGT-1500 FUEL ECONOMY PROGRAM	TAR	3	PIP	N	0	750	0
18	VARIABLE CAPACITY ENGINE	AVR	3	6.2	AH76	2,300	2,810	3,755
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.2	AH76	100	100	100
8	ADV. TURBINE COMPONENTS	TAR	4	6.2	AH91		422	0
78	ALTERNATE/MULTI-FUEL ENGINES FOR MEP	MER	4	6.2	AH20	700	1,500	1,500
10	ADV 1000 HP DIESEL ENGINE	TAR	3	6.3A	D607	0	380	0
1	ADIABATIC DIESEL ENGINE	TAR	4	6.3A	N	0	4,200	569
18	VARIABLE CAPACITY ENGINE	AVR	3	6.3A	N	0	11,000	15,000
17	IMPROVED HELICOPTER ENGINES	AVR	5	6.3A	D447	100	0	1,864
77	MULTI-SOURCE FUEL ENGINES FOR AIRCRAFT	AVR	5	6.4	DG72	3,600	8,000	6,000

Figure 23

OTHER EQUIPMENT—UNFUNDED (AS OF 15 AUG 79)
01/04/80

REF.	COMMAND OBJECTIVE TITLE	CMD	ENGY REL	RD CAT	PROJ	CFY	BFY	TFY
31	COMPARATIVE ANAL/MOB. CONST. EQUIP.	MER	3	MACI	5398	300	500	500
33	HYBRID FUEL CELLS	MER	3	MACI	3787	200	225	250
35	EFFICIENT ARMY WATERCRAFT	MER	2	PIP	N	0	0	500
39	EFFICIENT MOBILE LAUNDRY EQUIP	NAR	0	PIP	0012	215	0	0
19	FUEL CELL POWER PLANTS	MER	5	6.1	AH51	60	220	160
20	EFFICIENT MOBILE ELEC PWR SYSTEMS	MER	3	6.1	AH51	80	120	0
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.1	AH20	0	0	250
35	EFFICIENT ARMY WATERCRAFT	MER	2	6.2	AH20	200	300	0
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.2	AH99	1,323	1,473	1,410
48	FLUIDIC TEMPERATURE SENSOR	HDL	0	6.2	N	150	180	200
22	EFFICIENT ENV. CONTROL EQUIP.	MER	3	6.3A	DK39	0	0	1,425
38	EFFICIENT FIELD OVEN/GRIDDLE	NAR	1	6.3A	D610	32	5	0
36	RADIATION PRESERVATION OF FOODS	NAR	2	6.4	DL47	84	246	1,310

Figure 24

TABLE 6. DA GOAL VS RDT&E CATEGORY

DA GOAL	6.1			6.2			6.3A			6.4			MACI			PIP			DOE			MMT		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
1a.																								
Funded				100	75	200	1300	1840					700	1000								210	1280	1003
Unfunded													300	500	500									
Increment								450																
2a. (1)																								
Funded	680	470	470	1045	4350	3150	394	3557	11251				27	27	27									
Unfunded	60	220	475	800	1600	7725	1165	4480	3964	3600	8000	6600	200	225	250									
Increment																								
2a. (2)																								
Funded	1239	4123	1692	1699	1730	1860	4716	8637	6161										750					
Unfunded	80	120		2910	3910	4105	3100	11000	18289							1000	1500							

TABLE 7. DA GOAL 1a. VS COMMAND

		MER			TAR	
	FY80	FY81	FY82	FY80	FY81	YF82
Unfunded						
6.1						
6.2	100	75	200			
6.3A				1639	2211	1906
Unfunded						
MACI 300	500	500				
Increment						
6.3A		150				

TABLE 8. DA GOAL 2a. (2) VS COMMAND

	AMM			AVR			MER			TAR			ARO		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Funded															
6.1							120	80	80				1119	1343	1612
6.2	265	275	300	240	190	245	880	843	794	378	600	1071			
6.3A					837	5661	2200	1600	500	2922	2600	8181			
6.4							500	500	872						
DOE	750														
Unfunded															
6.1							80	120							
6.2				2410	2910	3855			250	0	422				
6.3A				100	11000	16844			1425	0	4580				
6.4															
PIP										1000	1500				

TABLE 9. DA *GOAL* 2*a*. (1) VS COMMAND

	AVR			DDL			MER			NAR			TAR		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Funded															
6.1				100			480	320	320	100	250	150			
6.2	50			165	100		830	2450	1150					1800	2000
6.3A		837	5661		250		1394	1320	2590						4000
MACI													27	27	27
Unfunded															
6.1							60	220	475						
6.2	100	100	100				700	1500	7625						
6.3A	100		1864				1065	1380	100					2300	
6.4	3600	8000	6600												
MACI							200	225	250						
Increment															
6.3A								300							

TABLE 10. TECHNICAL AREA VS RDT&E CATEGORY

	Funded			Unfunded			Increment		
	FY80	FY81	FY82	FY80	FY81	FY82	FY80	FY81	FY82
Fuels									
6.1	100	150	150			315			
6.2	630	2315	630			6125			
6.3A			200	1065	1380	100		450	
Engines									
6.2	949	2800	3196	3610	5410	5355			
6.3A	4166	9787	9161	3100	11000	16864			
6.4				3600	8000	6600			
PIP				1000	1500				
Other Equipment									
6.1	700	400	400	140	340	160			
6.2	1215	1050	934			250			
6.3A	2244	3410	2390			1425			
6.4	500	500	872						
PIP									
MACI				500	725	750			

SECTION 6. OVERALL ASSESSMENT/FINDINGS

Many of the new high-mobility, high-maneuverability equipment have increased or will increase rather than decrease fuel requirements. An example is the XM1 tank. To achieve the higher speeds required by the user and to power the additional tank-borne equipment will require higher fuel consumption rates. This, in turn, will increase the logistic requirements factor in terms of the additional tankers, pipelines, pumps, etc., required to meet the increased needs. A similar statement may be made for most mobility equipment, whether land or air. Therefore, the incorporation of energy factors into the specifications for design and engineering of future Army combat mobility and operational requirements will require additional resources as well as tradeoffs of other requirement considerations. For this reason, the specific nature of the Army's program in force structuring (equipment) will require careful analysis and critical judgments.

Based on 1977 data, the Army's share of DOD energy consumption is 17 percent. Of that amount, 83 percent is consumed in installation or facilities operations and 17 percent in mobility operations. Between FY73 and FY75, the Army reduced its consumption by 23.6 percent, exceeding the DOD goal by 8.6 percent. In FY75, the Army consumed 277 trillion Btu of energy at a cost of $545 million. In FY78, despite reductions of approximately 6.8 percent compared with FY75 level, the cost in year 2000 would be expected to exceed $3.1 billion. On the other hand, if the Army meets its newly adopted goals, the costs would be $1.8 billion in year 2000, resulting in a cost avoidance of $1.3 billion. The estimate for the total cost avoidance for the 20-year period between FY80 and FY2000 would be in excess of $11 billion. These energy-related savings do not take into account the Army's industrial support energy

requirement. It has been proposed that the Army use this cost avoidance in support of the funds needed to develop the Army programs to meet its goals and objectives.[1]

The Army Mobility Energy R&D Program provides a framework to reduce use of mobility fuels through improved engine efficiency, to develop multifuel engines, and to provide for introduction of synthetic fuels and alternative energy sources in Army mobile equipment.

It became obvious in developing an Army engine program that the DA policy accepted from the "Wheels Study" for vehicle engines needs to be reexamined in light of the recent developments in energy, particularly petroleum energy; and the emphasis on conservation, efficiency, and use of alternative fuels. The basic thrusts of the engine program should encompass:

a. RDT&E to develop engines that use other than conventional liquid fuels and/or multisource fuels;

b. RDT&E to improve efficiency of existing engines through new engine component developments and economic retrofit.

Other efforts that will be considered during CY80 are:

a. Contingency planning for the transition from petroleum to synthetic fuels;

b. Increasing the use of simulators in training (designed for maximum energy efficiency);

c. Modification or selection of automotive engine lubricating oils and other fluids for use with alternative fuels and for conservation.

The overall assessment or findings on the Army Mobility Energy R&D efforts, as they exist today, are:

a. The Army needs a better coordination process, within the R&D community, at the DA level and outside DA.

b. The Army needs to actively support and seek funding, or continue funding, energy relevant programs, especially alternative fuels, fuels and lubricants, and engine development.

c. The Army needs to reconsider that portion of the "Wheels Study" which essentially prohibits engine development work.

d. The Army organization and project structure is adequate to accomplish the R&D.

e. A methodology for determining "Energy Relevance" needs to be developed.

f. There is possibly limited funding for efforts towards petroleum conservation (reduce petroleum consumption by 10% by 1985) (See Tables 6 and 7).

1,400K in FY80	(6.2 and 6.3a)
1,915K in FY81	(6.2 and 6.3a)
2,000K in FY82	(6.2)

However, Mobility Energy R&D may not positively contribute toward this goal, particularly if many of the major projects introduce hardware into the field; e.g., the XM-1 consumes fuel at a much higher rate than the M-60.

Current funding for the Army goal of improving efficiency of (engines) mobility systems, 15% by the year 2000, is now low: (See Tables 6, 8, and 10)

7,654K in FY80	(6.1, 6.2, 6.3a)
11,790K in FY81	(6.1, 6.2, 6.3a)
9,713K in FY82	(6.1, 6.2, 6.3a)

when compared to total requested funds:

12,744K in FY80 (funded and unfunded)

26,820K in FY81 (funded and unfunded)

32,107K in FY82 (funded and unfunded)

The funding for the Army goal of converting 20% of mobility operations to alternative/synthetic fuels by year 2000 appears to be funded at about one-half of the total requested. The largest shortfall is for qualification of Army aircraft on alternative fuels (See Tables 6, 9, and 10).

APPENDIX A

SECTION 1. FUELS

APPENDIX A

Appendix A shows the prioritized Command objectives furnished by the respective Commands in response to letter, DRDME-ES 18 June 1979, Subject: DARCOM Energy R&D Seminar/Energy R&D Plan. All prioritized Command objectives are energy economy sensitive in support of the Army energy goals. A listing of those Commands responding, together with the reference retrieval numbers, is given prior to the project summaries. The prioritized Command objective includes programs in fuels, lubricants, engine development, material development, other fluid testing and development, equipment development, and equipment component development.

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Alternate/Synthetic Fuels.

Objective is to develop capability for Army equipment to operate on alternate/synthetic fuels as they become available.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000. Attain a position of leadership in the pursuit of national energy goals. Investigate use of shale oil as an alternate fuel source for mobility requirements. Develop adequate fuel specifications and fuel testing methods for a large slate of military fuels.

STOG REFERENCE:

80-8.2

MAJOR TECHNOLOGICAL BARRIERS:

Limited availability of fuels.
Unknown storage characteristics.

APPROACH:

Determine physical and chemical properties of new fuels. Conduct laboratory storage stability tests, single-cylinder and full-scale engine tests. Develop specifications for alternate/synthetic fuels. Conduct fleet tests on new fuels.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1	1T161102AH51		(Incr)	315	315	100	150
6.2	1L762733AH20	350	2165	430	700	750	850
			(Incr)	6125	6850	4000	1550
6.3							
6.4							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: User Acceptance Testing.

Objective is to provide field acceptance evaluations to transition new POL products from the laboratory to the using units.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORT:

Provide contingency planning for the transition from petroleum to synthetic fuels. Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

STOG REFERENCE:

80-3.12	80-8.2
80-5.1:17	80-8.20
80-5.1:18	
80-7.1:5	
80-7.1:14	

APPROACH:

Conduct field evaluations of crude oil as an emergency fuel, shale-derived fuels, lubricants for engines burning high-sulfur fuel, corrosion-inhibited lubricants, and engine oils from recycled base stocks.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2							
6.3	1L263104D150		(300)	350	1500	1500	1500
6.4							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Fuel Stability and Test Development.

Objective is to develop fuels and/or additive packages to increase storage life of military fuels up to four years.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Develop adequate fuel specifications and fuel testing methods for a large slate of military fuels.

STOG REFERENCE:

80-8.3
80-8.4
80-7.1:14
80-7.1:28

MAJOR TECHNOLOGICAL BARRIERS:

Laboratory tests do not always correlate well with field experience.

APPROACH:

Continue laboratory analysis of fuels from POMCUS facilities and depots. Conduct field tests of fuel stabilizing additive packages.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	1L762733AH20	100	75	100	125	150	150
6.3							
6.4							

COMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Military Fuel Monitor.

Objective is to develop a fuel quality monitor to assess the quality of diesel fuel in vehicles in storage on a go/no go basis.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Develop adequate fuel specifications and fuel testing methods for a large slate of military fuels.

STOG REFERENCE:

80-7.1:14
80-7.1:28
80-8.4

APPROACH:

Assemble equipment and evaluate against known quality fuels. Coordinate with user activities to provide satisfactory results.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2							
6.3	1L263a04D150		(180)	100			
6.4							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: High Energy Fuels.

Objective is to develop and test fuels with higher energy content per gallon to increase vehicle range 10 to 20 percent.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20% of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000. Develop adequate fuel specifications and fuel testing methods for a large slate of military fuels.

STOG REFERENCE:

80-7.1:5
80-8.2

MAJOR TECHNOLOGICAL BARRIERS:

High cost of synthesized high-energy fuels.
Poor engine operation on carbon slurry fuels.

APPROACH:

Evaluate micronized coal/diesel fuel as a high energy fuel.
Evaluate fire-safety characteristics of high energy fuels.
Determine physical and chemical properties of high energy fuels.
Conduct limited field test and develop specifications for high energy fuel.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	1L762733AH20	100	75	100	100	450	450
6.3	1L263104D150		(150)	200			
6.4							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTIVE PAYOFF: Enzymatic Hydrolysis of Cellulosic Materials:

Conversion of cellulose to alcohol for use as a gasoline extender (gasohol) would reduce consumption of petroleum in mobility operations.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

STOG REFERENCE:

80-7.1:4,6,23

MAJOR TECHNOLOGICAL BARRIERS:

Enzyme production, substrate pretreatment, and fermentation of enzymatic hydrolyzates to ethanol.

APPROACH:

a. Fungal mutation and enzyme production process optimization.

b. Integration and optimization of alcohol production.

c. Development of compression milling pretreatment for commercialization.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1	1L161102AH5205	100	150	150	150	150
6.2						
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

NARADCOM/5

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Gasohol Evaluation.

Reduce dependence on petroleum fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

APPROACH:

Investigate storage effects and material compatibility of Gasohol. Perform engine dynamometer and fleet testing with Army equipment using Gasohol. Evaluate effects on associated equipment.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	AH20	130					
6.3A	D150	(1065)	(1230)	(100)			
6.3B							
6.4							
PIP							

COMMAND/PRIORITY:

MERADCOM

APPENDIX A

SECTION 2. LUBRICANTS

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Objective is to develop tests, specifications, and procedures which will allow use of recycled oil in Army vehicles. Use of recycled oils.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce dependence on nonrenewable and scarce resources by the year 2000.
Attain a position of leadership in the pursuit of national energy goals.

STOG REFERENCE:

80-8:20

MAJOR TECHNOLOGICAL BARRIERS:

Bench tests do not always correlate with engine tests.

APPROACH:

Test re-refined base stocks under cooperative program with NBC.
Develop bench test methodology for oil quality.
Test recycled oils in tactical engines.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	1L762733AH20	100	90	50	150	150	250
6.3							
6.4							

COMMAND/PRIORITY:

MERADCOM/

APPENDIX A

SECTION 3. ENGINE DEVELOPMENT

CATEGORY I

Dedicated Energy Conservation Projects

ADIABATIC DIESEL ENGINE

OBJECTIVE AND EXPECTED PAYOFF:

The adiabatic diesel engine program will provide the technology required to develop a diesel engine that significantly reduces heat losses and thus significantly improves engine performance and eliminates the cooling system. Payoffs include improvements in fuel economy of 30 percent, reduction in volume and weight of 40 percent, an increase in power output of 100 percent and virtual elimination of the cooling system.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent. Improve efficiency of propulsion systems.

STOG REFERENCE:

79-3.2.0
79-7.1.12.

APPROACH:

Utilize high temperature materials (i.e., ceramics) to insulate the combustion system components of a diesel engine. No engine water coolant is provided as in a conventional liquid cooled engine.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
6.2	1L662601AH91	$511K	$425	$600	$550	$1400 (400)	$1400 (3000)	$2400 (3600)
6.3A			$566K	(4200)	6531 (569)	6000	4500	4000

COMMAND/PRIORITY:

TARADCOM/1

CATEGORY I

Dedicated Energy Conservation Projects

ENGINE CONCEPTS FOR ALTERNATE FUELS

OBJECTIVE AND EXPECTED PAYOFF:

Examine the feasibility of converting current engine systems to burn fuels in accordance with the future military fuels scenario.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuel by the year 2000.

STOG REFERENCE:

79-8.2c
79-7.1.12
79-3.2.o

APPROACH:

Evaluate wide cut fuels, alcohol-gasoline blends, high sulfur diesel fuel, fire safe fuels with intermediate use of shale derived, followed by coal derived liquids. High interest is current in the use of shale and coal derived liquids in blends of 5-10 percent. Develop advanced research piston and turbine engines and combustion systems for higher efficiency and performance when burning these fuels of the future.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.2	Not assigned	0	$900K	$1000K	$1500K	$1777	1777
6.3A			(1150)	2000K	3500K	3500	3600

COMMAND/PRIORITY:

TARADCOM/4

CATEGORY I

Dedicated Energy Conservation Projects

AGT-1500 FUEL ECONOMY PROGRAM

OBJECTIVE AND EXPECTED PAYOFF:

Reduce the mission fuel consumption of the AGT-1500 Army Ground Turbine by decreasing the idle fuel flow, obtaining an average 10 percent reduction in fuel consumption throughout the power range of the engine, and achieving the greatest percentage of fuel reduction in the 40-50 percent power range.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operation by 10 percent. Improve efficiency in propulsion systems.

STOG REFERENCE:

79-3.2
79-7.1.12
79-8.2c.

APPROACH:

The program involves the redesign of the power turbine to optimize the flow size, improve the hot section performance by reductions in temperature variance ratio, increase gas producer aerodynamic performance, improve effectiveness and pressure loss characteristics of recuperator and redesign high pressure compressor to a two axial and one centrifugal wheel configuration for higher efficiency and a simple unit.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
6.3A	1L263621DG07	$850K	$1606K ($1000K)	750	1650	3150	2600	2500

COMMAND/PRIORITY:

TARADCOM/2

CATETORY II
Supportive Energy Conservation Projects

M113 PIP

OBJECTIVE AND EXPECTED PAYOFF:

To improve the power plant efficiency of the M113A1 Armored Personnel Carrier. Improve fuel economy and operation efficiency.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent. Improve efficiency in propulsion systems.

STOG REFERENCES:

PIP 1-77-05-6501

APPROACH:

Five test vehicles have accumlated 37,533 miles of DT and OT testing. During the DT testing at APG, a comparison performance test was conducted between the M113E1 and the M113A1 vehicles. The M113E1 had an average fuel consumption improvement of 9% and a maximum improvement of 27% over the cross country (Perryman 3) course. The Allison X200 transimission is responsible for a large portion of the improvement. The production decision will be made at the IPR in September 1979.

FUNDING	DA PROJECT NUMBER	FY79
PEMA	17705650152	$300K

COMMAND:

TARADCOM

CATEGORY II
Supportive Energy Conservation Projects

TURBINE ENGINE COMBUSTION RESEARCH
PURDUE UNIVERSITY

OBJECTIVE AND EXPECTED PAYOFF:

Obtain fuel effects upon gas turbine combustor performance to provide a combustion model with guidance parameters for military engine requirements for military engine developments and manufacturing increased, combustion efficiency, fuel economy improvement and multifuel capability for turbine engines.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Increased efficiency, increased fuel economy and multifuel capabilities.

STOG REFERENCE:

79-3.2o
79-7.1.12
79-8.2c

APPROACH:

Combustor performance characteristics including combustion efficiency, flame stabilization with lean blow-off limits, smoke concentrations, flame radiation and ignition are being addressed in the burning of JP4, Jet A blended with 10-20 percent residual fuels and shall derived diesel fuel marine and VP5 in an experimental combustor. The program is planned to be completed in 1981.

FUNDING	DA PROJECT NUMBER	FY79	FY80
6.2	1L162601AH91	$138K	
6.2	1L762733AH20	35K	62K

COMMAND:

TARADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop the technology for efficient multifuel-operable military engines based upon anticipated available fuels. Reduction of required fuel, storage and logistic transport of fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

Reduce dependence on nonrenewable/scarce fuels by the year 2000.

STOG REFERENCE:

80-3:2 (10, 12) Combined Arms Capable Vehicle, Aircraft Survivability, Improved Helicopter.

MAJOR TECHNOLOGICAL BARRIERS:

Factual understanding of the interaction of engine combustion phenomena with regard to fuel characteristics in terms of ignition, flame propagation rates, chemical reactivities, mixing, emissions, etc., so as to effectively design chamber geometry and combustor flow parameters and reduce cooling and hot gases emission losses.

APPROACH:

Develop fuel-combustion I.C.E. and Brayton-type engines for military vehicle propulsion with enhanced performance fuel efficiency.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1	1L161102BH57	1,119K	1,343K	1,612K	1,934K	2,321K

COMMAND/PRIORITY:

U.S. Army Research Office

Priority - not applicable

CATEGORY II

Supportive Energy Conservation Projects

ADVANCED TURBINE COMPONENT RESEARCH

OBJECTIVE AND EXPECTED PAYOFF:

To develop technology to produce turbine components with high temperature and high efficiency capabilities.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent and increase efficiency in propulsion systems.

STOG REFERENCE:

79-3.2o
79-7.1.12
79-8.2c

APPROACH:

This project is made up of four tasks:

a. A single advanced design, radial inflow turbine stage will replace multiple, axial stages.

b. Ceramic coatings will reduce heat transfer in respective engine elements allowing higher operating temperatures.

c. A reheat combustor will be developed to cut turbine fow lossers, there by reducing the air clearner subsystems by nominal 45 percent.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
6.2	1L662601AH91	$150K	$314K	0	$521K	$1000K	$14250K	750
			($500K)	(422)			(575)	

COMMAND:

TARADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Heat Engine Vehicle Systems Materials and Components Technology

The objectives are to provide continuing technical support to DOE and NASA, to carry out evaluations of new and/or improved ceramic materials as they relate to the hot path of turbine and the high temperature surfaces of piston engines. This effort parallels and compliments direct Army effort in turbine and diesel engine improvements.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent.

STOG REFERENCE:

80:3.2a

MAJOR TECHNICAL BARRIERS:

1. Comparison of various techniques to estimate survival times of tension specimens, discs, and rotors.

2. Development and refinement of methodology to predict engine component behavior.

APPROACH:

Conduct evaluation of prime candidate materials, particularly in the development and exploitation of Si_3N_4 with additives, and to maintain a data base of flexural strength as a function of stress rates and temperatures of proof testing and life prediction.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	N/A - DOD/DOE 1AA	750K				
6.3A						
6.3B						
6.4						
PIP						

COMMAND PRIORITY:

AMMRC/4

CATEGORY II
Supportive Energy Conservation Projects

ADVANCED 1000 HP DIESEL ENGINE

OBJECTIVE AND EXPECTED PAYOFF:

Develop an advanced 1000 HP Diesel Engine which specifically emphasizes low specific weight and volume, excellent response for high mobility and agility, excellent fuel economy and performance, and a very low acquisition cost. A 10 percent reduction in fuel use.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operation by 10 percent.

STOG REFERENCE:

79.3.2o
79-7.1.12
79-8.2c

APPROACH:

Advanced engine designs and a new turborcharger will be applied to a production base engine for future demonstration at 1000 HP. The design features include low compression ratio, high pressure turbocharging, high efficiency turbocharger and turbo-compounding.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
6.3A	1L263621D607	0	750	2600 (380)	0	0	0	0

COMMAND:

TARADCOM

CATEGORY II

Supportive Energy Conservation Projects

ADVANCED HYDROMECHANICAL TRACKED TRANSMISSION (CVX-650)

OBJECTIVE AND EXPECTED PAYOFF:

Advance the state of technology in hydromechanical tracked transmission design. Increase transmission performance efficiency and controls by prototype development and testing. A 10 percent reduction in fuel economy.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption mobility operations by 10 percent. Improved efficiency of propulsion systems through designs of new equipment.

STOG REFERENCE:

79.3.2o
79-7.1.12

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
6.3A	1L263621D395	$1410K	$1639K	$2211K	1906	984	740	0

COMMAND:

TARADCOM

CATEGORY II

Supportive Energy Conservation Projects

MACI - TRANSMISSION AND TRANSFER ASSEMBLIES

OBJECTIVE AND EXPECTED PAYOFF:

The objective of this project is to apply the latest state of technology components available from the commercial make to military wheeled vehicles for technical evaluation and assessment. Five percent reduction in fuel use.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduced energy consumption in mobility operation by 10 percent. Improved efficiency of propulsion systems.

STOG REFERENCE:

79.3.3o
79.7.1.12

APPROACH:

Commercial transmissions and transfer cases will be tested for application to tactical wheeled vehicles. The testing will determine the performance/installation characteristics and durability under military conditions.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
MACI	1L263621D607	$365K	$282K	(420)	(440)	(460)	(460)	(470)

COMMAND:

TARADCOM

CATEGORY II
Supportive Energy Conservation Project

ELECTRIC VEHICLE EVALUATION

OBJECTIVE AND EXPECTED PAYOFF:

To evaluate electric drive vehicles in use on post, camp and stations environments and potential component application for tactical vehicles. Reduce use of petroleum fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent.

APPROACH:

Five electric drive vehicles will be evaluated at Red River Army Depot's "Energy Showcase" for use in the 1/4 to 1-1/4 ton class pick-ups and vans. The program will evaluate vehicle performance, durability, battery life and use of solar energy for recharging the batteries. The Department of Energy is supplying funds for the procurement of the vehicles.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82
MACI	T794331	$63K	$27K	$27K	$27K

COMMAND:

TARADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Confirm the capability of and/or define required modifications to existing helicopter engines to allow operation on a wide range of alternate fuels and develop new engine technology to effect a 40 percent reduction in fuel consumed for future helicopter systems relative to today's aircraft.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent.
Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels.
Improve efficiency of propulsion systems through design of new equipment.

STOG REFERENCE:

80 - 3:12 (U) (6, 10) Improved Helicopter
80 - 7.1:4 (U) (6, 10) Improved Aircraft Performance

MAJOR TECHNOLOGICAL BARRIERS:

No major technological barriers are foreseen. New engine development will be required utilizing advanced technology.

APPROACH:

Evaluate performance of existing and emerging gas turbine engines on synthetic/alternate fuels by full engine test.

Provide a validated technology base and/or develop/demonstrate advanced technology engines for air mobility systems.

- Perform individual engine component research.
- Define potential energy (fuel) savings available from utilization of advanced engine technology.
- Demonstrate achievable improved performance through the integration of advanced technology components into new engines.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.2	1L162209AH76	50 (100)	(100)	(100)	(100)	(100)
6.3A	1L263201D447	(100)	837	5661 (1864)	9325 (2933)	4595

COMMAND:

AVRADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop the technology in the components and systems areas for the Variable Capacity Engine for Army air mobile systems. Reduction of petroleum usage and associated cost.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.
Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degration of readiness.
Improve efficiency of propulsion systems through design of new equipment.

STOG REFERENCE:

80 - 3:12 (U) (6, 10) Improved Helicopter

MAJOR TECHNOLOGICAL BARRIERS:

Development of variable geometry compressors and turbines (especially compressor inlet guide vanes and diffusers, and turbine nozzles).

APPROACH:

Apply various variable geometry features in a turboshaft engine that would enable it to operate near peak pressures and efficiences over most of its operating range. Develop components (compressors, combustors, and turbines) that will operate at a constant pressure ratio and work level as engine airflow is varied over a broad range (between 50 percent and 110 percent power). The areas of research that must be explored are:

- Overall cycle parameters
- Range of flow needed
- Design point performance of components
- Fuel control requirements
- Mechanical design for variable geometries
- Cooling requirements
- Engine size and ratings

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84
6.1							
6.2	1L162209AH76	520	190 (2310)	190 (2810)	245 (3755)		
6.3A				(11000)	(15000)	(9000)	(6000)

6.3B

6.4

PIP

COMMAND/PRIORITY:

RTL (AVRADCOM), Propulsion Laboratory

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop efficient mobile electric power systems which utilize nonpetroleum derived fuels. Convert 20 percent of military generator inventory from gasoline/diesel engine generators to fuel cells.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by year 2000.

STOG REFERENCE:

80 - 7.1:10

80 - 8:2

MAJOR TECHNOLOGICAL BARRIERS:

Improved stability and reactivity of catalysts for both fuel cell electrodes and fuel processor subsystems.

APPROACH:

Develop fuel cell electric power generators. Conduct research in electrocatalysis and reaction mechanisms and kinetics of fuel cell reactions. Determine electrode sintering and corrosion mechanisms and devise methods for improving catalyst and substrate stability. Develop diagnostic techniques for analyzing power plant behavior. Determine tolerance of fuel cells to impurities in fuels. Evaluate new electrolytes which offer improvements in performance and decreases in weight and volume. Develop catalysts which are highly efficient and stable for conversion of logistic fuels into a subsystems with improved efficiency. Develop a family of methanol fueled fuel cell power plants to replace military gasoline engine driven generator sets. Develop metal hydride fueled fuel cell power sources to fulfill power requirements that cannot be adequately handled by batteries or engine generator sets.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1	1L16110241151	480 (60)	320 (220)	320 (160)	320 (160)	320 (200)	
6.2	1L162733AH20	300	220	270	250	250	
6.3	1L263702DG11	394	1320	2390	1058 (700)	915 (800)	2565
6.4	1F464714D196	4345	4260	1239	3340	4535	
PIP							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Improve efficiency of mobile electric power systems. Reduce fuel consumption in the generation of electrical power for mobility operations by 10 to 20 percent.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operation by 10 percent by FY85. Increase efficiency of nonrenewable energy dependent mobility system by 15 percent with no degradation in readiness.

STOG REFERENCE:

STO 80-7.1.8, 7.1.9, 7.1.10

MAJOR TECHNOLOGICAL BARRIERS:

Conduction mechanism and stability of graphite intercalation compounds.

Shapeability and maximum size of amorphous metal strips.

Modularization of solid-state equipment and development of power functions.

APPROACH:

Improve efficiency and energy conservation by applying novel, emerging materials to the design of electrical machinery, power conditioning and distribution equipment. Of particular interest in the machinery area are low-loss lamination materials such as amorphous metals which are now becoming available in small quantities and narrow strips. Work is needed to obtain wider strips required for rotating machine applications. Because of material hardness, direct shaping of the laminations, rather than use of punched laminations, may become necessary. Graphite intercalation compounds show high promise for use as electrical conductors, with conductivity exceeding that of copper while being lighter than copper. Initial proposed use of these materials would be for distribution and transmission of electrical power, followed by use in electrical machinery assuming satisfactory mechanical properties can be obtained. In the power conditioning area, modularization of equipment will permit simplification of circuitry, reduce component count, improve thermal management and thus reduce losses. In many applications, power conditioner will replace less efficient motor-generator and engine-generator sets.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1	1L161102AH51	120 (80)	80 (120)	80	80	--	--
6.2	1L162733AH20	600	530	550	550	550	630
6.3A	1L263702DG11	550	--	--	--	--	--
6.3B							
6.4							
PIP							

COMMAND/PRIORITY

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop efficient mobile electric power systems which utilize nonpetroleum derived fuels. Convert 20 percent of military generator inventory from gasoline/diesel engine generators to fuel cells.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by year 2000.

STOG REFERENCE:

80 - 7.1:10

80 - 8:2

MAJOR TECHNOLOGICAL BARRIERS:

Improve stability and reactivity of catalysts for both fuel cell electrodes and fuel processor subsystems.

APPROACH:

Develop fuel cell electric power generators. Conduct research in electrocatalysis and reaction mechanisms and kinetics of fuel cell reactions. Determine electrode sintering and corrosion mechanisms and devise methods for improving catalyst and substrate stability. Develop diagnostic techniques for analyzing power plant behavior. Determine tolerance of fuel cells to impurities in fuels. Evaluate new electrolytes which offer improvements in performance and decreases in weight and volume. Develop catalysts which are highly efficient and stable for conversion of logistic fuels into a hydrogen rich fuel feed for fuel cells. Develop advanced fuel cell subsystems with improved efficiency. Develop a family of methanol fueled fuel cell power plants to replace military gasoline engine driven generator sets. Develop metal hydride fueled fuel cell power sources to fulfill power requirements that cannot be adequately handled by batteries or engine generator sets.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1	1L16110241151	480 (60)	320 (220)	320 (160)	320 (160)	320 (200)	
6.2	1L162733AH20	300	220	270	250	250	
6.3	1L263702DG11	394	1320	2390	1058 (700)	915 (800)	2565
6.4	1F464714D196	4345	4260	1239	3340	4535	

PIP

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop advanced heat engines. Reduce petroleum fuel consumption in gas turbine electrical power generation and related turbine driven equipment by 40 percent and diesel engine driven equipment by 15 percent.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degration to readiness. Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degradation to readiness.

STOG REFERENCE:

STOG 80 - 7.1.7 Power Generators
QMR - Family of Mil Des Power Plants
MN(ED) - 10KW Member of Family of Mil Des Power Plants

MAJOR TECHNOLOGICAL BARRIERS:

High temperature materials.
Durability in high performance exhaust heat recovery components.
Control systems.

APPROACH:

Develop more fuel efficient engines for mobile electric power systems. Investigate improvements to diesel engines by utilizing advanced turbocharging techniques to permit improved fuel efficiency without degradation of electrical power output quality. Investigate improvements to gas turbines by development of ceramic components to enhance high cycle temperature capability and exhaust heat recovery devices. The increased cycle temperature capability results in higher power density and lower fuel consumption, while use of waste heat recovery results in further significant reduction in fuel consumption. Greatest immediate payoff is foreseen in small gas turbine power units and 6.3/6.4 program is directed to power plants in the 10-30 KW power range.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	1L162733AH20	130	113	130	130	130	150
6.3	1L763702DG11	1650	1600	500			
6.4	1F764714D194				910	1500	2400

COMMAND/PRIORITY:

MERADCOM/	25	23	22	26	21	18

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZIED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop multifuel engines for tactical and combat vehicles. Reduce dependence on petroleum fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000. Develop multifuel engine.

APPROACH:

Conduct R&D to develop multifuel engines for various Army tactical and combat vehicles. Continue development effort related to improving AGT-1500 engine multifuel capability. Perform combustion research studies.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	AH91		900	1000	1500		
6.3A	DG07		0 (1150)	2000	3500		
6.3B							
6.4							
PIP							

COMMAND/PRIORITY:

TARADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Alternate/multifuel engine development for mobile electric power.
Reduce dependence on petroleum fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000. Develop multifuel engine.

APPROACH:

Perform multisource fuel-engine evaluations to select development candidates in spark ignition, compression ignition, and gas turbines. Conduct alternative fuel combustion research for both internal and external combustion engines. Develop selected engine combustion technology.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2	AH20	(700)	(1500)	(1500)	(2500)	(2500)	(1500)
6.3A							
6.3B							
6.4							
PIP							

COMMAND/PRIORITY:

MERADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Multisource fuel engine development for Army aircraft.
Reduce dependence on petroleum fuels.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000. Develop multifuel engine.

APPROACH:

Perform turbine engine qualification tests using aviation grade, shale derived fuels. Develop modifications where necessary and retrofit or replace turbine engines in existing aircraft.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1							
6.2							
6.3A							
6.3B							
6.4	DC72	(3.6M)	(8.0M)	(6.6M)	(5.4M)	(3.0M)	(.4M)
PIP							

COMMAND/PRIORITY:

AVRADCOM

APPENDIX A

SECTION 4. MATERIAL DEVELOPMENT

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Provide materials processing and property data to assure the availability of reliable, affordable ceramic component technology for advanced heat engines. These components are in support of the MERADCOM 10 KW GT and the TARADCOM Adiabatic Diesel.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Increase efficiency of non-renewable energy mobility systems by 15 percent with no degradation to readiness.

STOG REFERENCE:

80: 3.2a3

MAJOR TECHNOLOGICAL BARRIERS:

Developing current ceramics, which have been demonstrated in engines, to the required levels of reliability, fabricability and cost.

APPROACH:

High performance Si_3N_4 and SiC based ceramics can provide the uncooled, high temperature materials capability to reduce specific fuel consumption and increase specific power for the above engines. Improvements in processing for reliability and cost reduction, as well as property enhancement are being pursued. Emphasis is on net shape fabrication and generation of mechanical property data after long time thermal exposure. Basic understanding of processing/microstructure/properties is being developed to provide materials with optimized and reproducible properties.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162105AH84	265	275	300	275	200
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

AMMRC/3

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTED AND EXPECTED PAYOFF

Reduce fuel consumption by utilizing plastic production technique in lieu of higher energy consumption metal production techniques.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in facilities by 25 percent by FY85 and 50 percent by the year 2000.

STOG REFERENCE

808.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Develop sufficiently stable plastics with accurate molding technologies.

APPROACH

Techniques for fabricating inertial components from engineering plastics are being evaluated at Draper Laboratory with the objective of reducing weight and cost. By employing these techniques successfully, an energy savings will be accrued in the fabrication because of the shorter machine operation time to form parts in contrast to the machining of parts. Secondly, the weight reduction in the unit will afford a less massive missile payload thus reducing flight fuel consumption.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		250K	250K			
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 1

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Improvements of thermo-processed field meals. Reduction in processing energy and weight of field meals.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.

STOG REFERENCE:

79-7.1.10

MAJOR TECHNOLOGICAL BARRIERS:

Develop a flexible pouch, the flex pack, to replace the metal can in themally processed foods. Processing energy for flex packs is about half that for canned foods. The "meal-ready-to-eat" is about 30 percent lighter in weight than the meal, combat, individual.

APPROACH

The flex pack is used in the "meal-ready-to-eat" which is intended to replace the meal, combat, individual. A large procurement of flex packs has recently been initiated.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162724AH99BC001	200	160	146	77	82
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

NARADCOM/2

APPENDIX A

SECTION 5. OTHER FLUID TESTING AND DEVELOPMENT

ANTIFREEZE EXTENDER AND CONDITIONER SYSTEM

OBJECTIVE AND EXPECTED PAYOFF:

Develop a long-life coolant system to include a conditioner/filter unit and a corrosion monitoring device. This is expected to result in a substantially increased service life of coolant and cooling systems.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Conserve petroleum based glycol coolant and upgrade RAM-D factors. Decrease procurement costs of nonrenewable energy resources and increase readiness.

STOG REFERENCE:

STOG 80 - 7.1.14
80 - 8.2

MAJOR TECHNOLOGICAL BARRIERS:

None

APPROACH:

Conduct simulated service tests and limited field tests with commercial conditioner/filter to insure compatibility with military antifreeze. Fabricate units with military extender formulation and conduct full scale test in tandem with electronic corrosion monitoring device.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.2	1L762733AH20	100	100	125	125	125
6.3A	1L263104D150	-	-	200	-	-

COMMAND/PRIORITY:

MERADCOM/17

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

To assess the operational impact of utilizing nonpetroleum based hydraulic fluids in new and fielded construction and materials handling equipment.

To reduce/eliminate the use of nonrenewable fluids in the hydraulic systems of mobile construction and materials handling equipment.

To develop contingency plans for use in retrofitting fielded equipment to utilize new nonpetroleum based hydraulic fluids without loss of operational efficiency or system life.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption by 45 percent by the year 2000.

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

Reduce dependence on nonrenewable and scarce fuels by the year 2000.

Convert 20 percent of the mobility operations petroleum requirements to synthetic or alternate fuels by the year 2000.

Attain a position of leadership in the pursuit of national energy goals.

Contingency planning for the transition from petroleum to synthetic fuels.

MAJOR TECHNOLOGICAL BARRIERS:

None perceived.

APPROACH:

1. Acquire data and prepare a study regarding characteristics of material incompatibility when a military synthetics fluid is utilized in selected high density fielded construction equipment.

2. Provide test data to project potential degradation of operational performance or reduction in system life when synthetic fluids are introduced into a system designed for petroleum based fluids.

3. Study and develop procedures for accomplishing retrofitting of existing equipment to achieve acceptable material/fluid capability levels.

4. Provide appropriate TDP paragraphs to guide future procurement actions relative to introducing synthetic hydraulic fluids into the military system.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
MACI (3582)		150	200	200	150	150

COMMAND/PRIORITY:

APPENDIX A

SECTION 6. EQUIPMENT DEVELOPMENT

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF: Heat Engine Vehicle Systems Materials and Components Technology/

The objectives are to provide continuing technical support to DOE and NASA, to carry out evaluations of new and/or improved ceramic materials as they relate to the hot path of turbine and the high temperature surfaces of piston engines. This effort parallels and compliments direct Army effort in turbine and diesel engine improvements.

DA GAOL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent.

STOG REFERENCE:

80:3.2a

MAJOR TECHNICAL BARRIERS:

1. Comparison of various techniques to estimate survival times of tension specimens, discs, and rotors.

2. development and refinement of methodology to predict engine component behavior.

APPROACH:

Conduct evaluation of prime candidate materials, particularly in the development and exploitation of si_3N_4 with additives, and to maintain a data base of flexural strength as a function of stress rates and temperatures of proof testing and life prediction.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	N/A - DOD/DOE 1AA	750K				
6.3A						
6.3B						
6.4						
PIP						

COMMAND PRIORITY:

AMMRC/4

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Provide materials processing and property data to assure the availability of reliable, affordable ceramic component technology for advanced heat engines. These components are in support of the MERADCOM 10 KW GT and the TARADCOM Adiabatic Diesel.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Increase efficiency of non-renewable energy mobility systems by 15 percent with no degradation to readiness.

STOG REFERENCE:

80: 3.2a3

MAJOR TECHNOLOGICAL BARRIERS:

Developing current ceramics, which have been demonstrated in engines, to the required levels of reliability, fabricability and cost.

APPROACH:

High performance Si_3N_4 and SiC based ceramics can provide the uncooled, high temperature materials capability to reduce specific fuel consumption and increase specific power for the above engines. Improvements in processing for reliability and cost reduction, as well as property enhancement are being pursued. Emphasis is on net shape fabrication and generation of mechanical property data after long time thermal exposure. Basic understanding of processing/microstruction/properties is being developed to provide materials with optimized and reproducible properties.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162105AH84	265	275	300	275	200
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

AMMRC/3

CATEGORY II

Supportive Energy Conservation Projects

TRACK RUBBER

OBJECTIVE AND EXPECTED PAYOFF:

Increase track elastomer life about 50 percent and reduce the demand for petroleum base materials about 15 percent.

STOG REFERENCE:

79.3.4a, 79-7.1.11d.

APPROACH:

Prior efforts demonstrated the potential for a tri-blend compound based on natural rubber and two nonpetroleum based materials for use in track elastomers to extend life and reduce use of petroleum.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81
6.2	1L162601AH91	$169K	$225K	$300K

COMMAND:

TARADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop environmental control equipment with improved efficiency and multifuel capability. Reduce energy consumption by 10 to 20 percent.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness. Increase efficiency of nonrenewable energy dependent mobility systems by 15 percent with no degradation to readiness.

STOG REFERENCE:

80 - 3:2.G, -7.1:17, -7.1:23

MAJOR TECHNOLOGICAL BARRIERS:

Existing Equipment.

Continued requirements of compact and lightweight equipment is the greatest barrier to improving the efficiency of the present families of Environmental Control Equipment (ECE). The more compact the heater or air conditioner, the smaller the heat exchangers. This results in larger air moving devices to remove transferred heat and increase power to the refrigerant compressor and fan motors to effect the heat transfer.

New Concepts.

-Air Cycle Air Conditioner

Hindering this new concept is the lack of an efficient compressor-expander.

-Waste Heat Air Conditioner

A superior energy saving concept is an air conditioner that is powered by the hot (1000°F avg.) exhaust gases from the engines of Army generator sets. Transferring heat from the exhaust products of combustion to the heat powered air conditioner is the technical barrier.

-Total Environmental Control Systems (TECS)

Development of electronic controls for each capacity size TECS to accept various required electrical power inputs while yielding major energy savings.

APPROACH:

Air Cycle.

To overcome the air cycle technical barrier, a modestly funded exploratory development contract (6.2) was awarded in FY79 to produce a breadboard compressor-expander, initiating an effort to determine the internal losses including compressed air leakage, thermal expansion, heat transfer, friction and windage. Overcoming these losses will increase the efficiency of air cycle air conditioning and make it competitive on a life-cycle air conditioning and make it competitive on a life-cycle cost effectiveness basis with existing Army Environmental Control Equipment.

Waste Heat Powered Air Conditioner.

Using hot engine exhaust gases to power the Absorption Cycle can save 75 percent of the energy now consumed by a comparable electrically powered air conditioner. Heat exchanger development considering the fouling effects of engine exhaust is the approach beign taken to overcome the technical barrier to this concept.

Total Environmental Control System (TECS).

One of three capacity sizes is well along in advanced development. Operation from either 60 or 400 Hz is now state of the art with "soft start" advantages for all motors and significant energy reduction accompanying variable cooling requirements. New solid state methods will be investigated to permit acceptance of other voltage levels and single phase supplies.

250,000 BTUH Self-powered Multifuel Army Space Heater.

While the main thrusts of this heater development are improvements in reliability, safety, and effectiveness at low temperatures, the multifuel capability does have some energy saving benefits. It allows use of lower grades of fuel than the gasoline now needed for heaters in this size range and these fuels require fewer gallons of crude oil than gasoline. The heat is produced by this heater at fuel economy as good as or slightly better than existing equipment. The new heater can recirculate heated air rather than continually heating new, cold air. The new heater can be thermostatically controlled so that running time will be only as much as needed to supply the desired workspace temperatures.

FUNDING	DA PROJECT NUMBER	FY80	FY84	FY82	FY83	FY84	FY85
6.1							
6.2	AH20	150	200	144 (250)	100 (270)	100 (300)	
6.3A	DK39			0 (1425)	0 (1578)	500 (1452)	
6.3B							
6.4	DL39	500	500	872	562 (71)	0 (406)	2880 (320)
PIP							

COMMAND/PRIORITY:

MERADCOM/

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop a rigorous engineering process for the comparative analysis of the energy efficiency of mobile construction equipment.

Immediate measurable reduction in the use of petroleum through improved procurement selectivity at minimal loss of operational capability.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption by 45 percent by the year 2000.

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

Attain a position of leadership in the pursuit of national energy goals.

MAJOR TECHNOLOGICAL BARRIERS:

None perceived.

APPROACH:

1. Establish a reference duty cycle for each generic type of consturction equipment (high use/high density types first).

2. Measure amount of petroleum (or petroleum equivalents) used to perform the reference duty cycle.

3. Compare energy usage rate between both similar propulsion systems and alternatives (electric, LP gas, etc), calculating alternate in terms of barrels of petroleum.

4. Draw engineering conclusions regarding design characteristics which tend to result in optimal energy conservation with minimal effect on operational productivity.

5. Project potential energy saving for presentation to the decision maker.

6. At the request of the user - input energy efficiency as a figure-of-merit in mobile equipment requirement documents.

7. Press for adoption by SAE of the need for equipment manufacturers to certify and publish the energy efficiency rating of their equipment for use by their customers.

8. Utilize these numbers as critical factors for future construction equipment contract awards.

Note: It is envisioned that this energy efficiency rating would be analagous to a DBa noise level rating or an EPA estimated mileage rating. The engineering involved is basically that of determining how to measure fairly with a high degree of repeatability and reproducibility and to express the characteristic in an appropriate figure-of-merit.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
MACI (5398)		300	500	500	300	100

COMMAND/PRIORITY:

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Determine the feasibility/practicality of utilizing hybrid fuel cells to power specific material handling vehicles.

To reduce the continued dependence on nonrenewable energy as a power source for forklift trucks.

To reduce the pollution and safety hazards imposed on military personnel operating forklifts in confined ammunition storage igloos.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce dependency on nonrenewable and scarce fuels by the year 2000.

Convert 20 percent of the mobility operation petroleum requirements to synthetic or alternate fuels by the year 2000.

Attain a position of leadership in the pursuit of national energy goals.

Develop propulsion units utilizing other than conventional liquid fuels.

MAJOR TECHNOLOGICAL BARRIERS:

None perceived.

APPROACH:

It is anticipated that the project would involved a joint effort by both M&CE and the Electrical Technology Laboratories. The development of the hybrid fuel cell as an alternative power source would be reconstituted based on the need for energy reallocation. The prototype installation would be applied to small electric/gasoline powered forklift trucks to demonstrate practicality and to answer an immediate military need in the area of ammunition handling.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
MACI (3787)		200	225	250	300	350

COMMAND/PRIORITY:

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Develop training simulator for Bridging in the 80's transporter/launcher. Reduction in petroleum requirements, "hands-on" machine time, equipment breakage, and associated costs.

DA GOAL(S) SUPPORTED AND ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in training by 25 percent. Increase use of simulators in training.

STOG REFERENCE:

80-8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS:

None.

APPROACH:

Develop (1) movie simulator, or (2) computer simulator with video display, or (3) working scale model.

FUNDING	DA PROJECT NUMBER	FY83	FY84	FY85
6.3A*		0 (500)	0 (500)	0 (500)

COMMAND/PRIORITY:

*Funding based on video display option.

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Reduce water consumption, fuel costs and weight of mobile laundry equipment. Reduction in fuel costs of 25 percent, water consumption 50 percent, and weight 5 percent are anticipated.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.

STOG REFERENCE:

N/A

MAJOR TECHNOLOGICAL BARRIERS:

Determine the most promising laundry detergent formula.

APPROACH:

Add a counterflow wash water recovery system to the single trailer laundry unit which will accommodate the use of cold water laundry detergent/supplies and wash formulas.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2						
6.3A						
6.3B						
6.4						
PIP	1-80-08-0112	0 (215)	125	0	0	0

COMMAND/PRIORITY:

NARADCOM/6

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Radiation Preservation of Foods
Reduction in refrigeration and cooking energy; less refrigeration requires less mobile electric power.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10% by FY85.

STOG REFERENCE:

79-7.1.10

MAJOR TECHNOLOGICAL BARRIERS:

(1) Approval by FDA and USDA of irradiated food process, (2) FDA requirement to conduct long-range expensive animal feeding studies, (3) lack of interest in irradiated food process by food industry until FDA approval is granted. Radiation sterilized meats are enzyme inactivated and can be stored for years without refrigeration. For example, frozen cut-up chicken from slaughter, 3.5 weeks frozen storage to cooked condition, has an energy requirement of 46,000 kJ/kg edible portion contrasted to radiation sterilized, cooked individual servings which have a comparable energy requirement of 14,160 kJ/kg edible portion.

APPROACH:

Conduct basic and applied research regarding the radiation preservation of food. Develop specific irradiated food items, and obtain approval by FDA for general consumption of these items. Already approved is sprout inhibition for onions and potatoes, also disinfestation of wheat and wheat products.

FUNDING	DA PRODUCT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1 6.2	1L762724AH99D	1020 (1323)	1000 (1473)	750 (1410)	500 (1378)	300 (1038)
6.3A						
6.3B						
6.4	1G764713DL47	2499 (81)	2134 (246)	1060 (1310)	200 (1280)	50 (400)
PIP						

COMMAND/PRIORITY:

NARADCOM/1

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Reduction of food weight and bulk. Less volume and weight require less mobility petroleum for distribution. Reduction in mobile electric power for refrigeration.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.

STOG REFERENCE:

79-7.1.10

MAJOR TECHNOLOGICAL BARRIERS:

Use of microwave plasticizing in freeze drying/compression process will reduce freeze drying time by 50 percent over the current freeze drying method. Freeze-dried/compressed food has 75/94 percent less volume, requires 13/30 percent less production energy over canned/frozen foods. Refrigeration is unnecessary.

APPROACH:

The new freeze drying/compression process is being tested on all previously freeze-dried products.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162724AH99BB103*	67	145	135	150	175
6.3A						
6.3B						
6.4						
PIP						

*FY81 and out - project 1L162724AH99BB102

COMMAND/PRIORITY:

NARADCOM/4

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Improvement in food packaging.
Reduction in energy spent in food processing, storage, and heating to serving temperature.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.

STOG REFERENCE:

79-7.1.10

MAJOR TECHNOLOGICAL BARRIERS:

Development and test of a hermetically sealed tray pack food container. It is half steam table size, used as a processing, storage, reheating and serving vessel. Saves one half the processing energy of #10 can; one third reheating energy compared to frozen foods. Does not need to be refrigerated in the field; warewashing unnecessary as it is disposable.

APPROACH:

Tray pack replaces #10 can and is alternative to frozen foods. Steel, tinplate and plastic containers are under evaluation.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162724AH99BC008	30	Completed			
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

NARADCOM/8

ARMY ENERGY R&D PROGRAM FOR MILITARY OPERATIONS

OBJECTIVE AND EXPECTED PAYOFF:

Reduce fuel consumption of Army watercraft and marine systems by ten percent.

DA GOAL SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREAS SUPPORTED:

Reduce energy consumption in mobility operations by ten percent by FY85 with zero groth to the year 2000 with no degradation to readiness. Improve propulsion systems through design of new equipment and economic ratrofit of old equipment. Increase use of simulators in training.

STOG REFERENCE:

STOG 79 - 8.11.c.

MAJOR TECHNOLOGICAL BARRIERS:

None.

APPROACH:

Conduct fuel consumption systems analyses of watervraft and marine systems to determine consumption profiles and major sources of fuel usage. Select candidate systems and conduct detailed studies on methods, procedures and designs to improve efficiency and reduce fuel consumption. Conduct cost and economic analyses on selected systems to justify further development or product improvement. Conduct development and/or product improvement to include test and evaluation of prototype systems. Prepare Technical Data Package reflecting changes or new designs required.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.2	AH20SM	(200)	(300)			
PIP				(500)	(750)	(750)

COMMAND/PRIORITY:

MERADCOM

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Improvement of field oven and griddle, Bare Base System. Reduction in petroleum consumption for cooking in the field.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by 1985.

STOG REFERENCE:

DOD Food Program Requirement USAF 8-8

MAJOR TECHNOLOGICAL BARRIERS:

Development of a heat pipe griddle and more energy-efficient oven for the Air Force Bare Base System integrated kitchen facility. Griddle design and choice of working fluid are important to a successful unit. Heat pipe griddle is expected to use half the petroleum energy of existing unit.

APPROACH:

Heat pipe griddle, besides using less fuel, has a much shorter preheat time, quicker recovery, and much more uniform temperature over the heating surface than the present griddle. Contract to Dynatherm in study phase now; prototype to follow.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2						
6.3A	1L263747D61004016	83 (32)	120 (5)	0	0	0
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

NARADCOM/7

AD-A088 860 ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT COMM--ETC F/G 15/7
ARMY MOBILITY ENERGY RESEARCH & DEVELOPMENT PLAN.(U)
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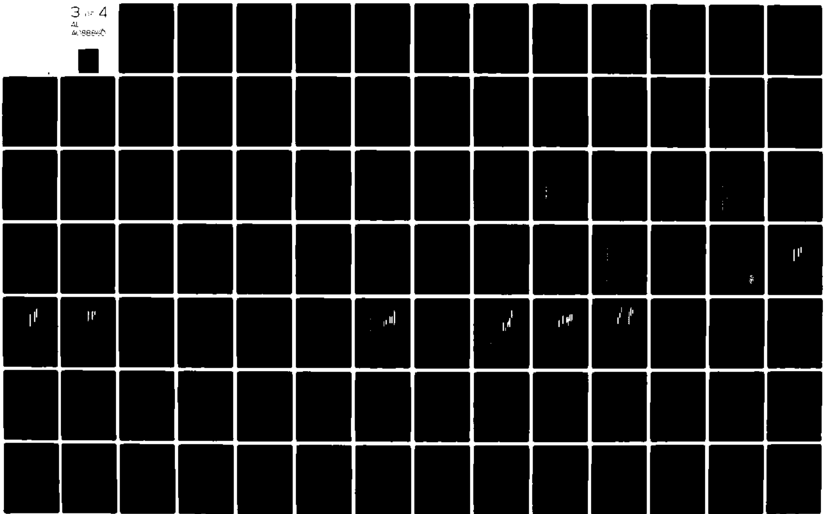

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Airdrop simulation.
Reduction in number of flight tests for development of airdrop systems would reduce fuel usage.

DA GOAL(S) AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent by FY85.

STOG REFERENCE:

79-5.1.10(21)

MAJOR TECHNOLOGICAL BARRIERS:

Define and develop simulation techniques.

APPROACH:

Scale modeling and use of laboratory simulation may lead to the identification of critical parameters which otherwise might not have been detected until considerable energy was expended in a "cut and try" test program.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162210D283AG	120	200	200	200	200
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

NARADCOM/3

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Further develop samarium-colbolt generator technology to provide more powerful hand cranked units and to start the development of wind driven units suitable for US Army field use.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Convert 20 percent of mobility operation to nonpetroleum fuel by year 2000. Reduce energy consumption by 10 percent.

STOG REFERENCE:

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS:

The need to define existing engineering principles as they relate to maximizing the energy output of hand cranked generators. The need to develop small, compact wind driven units suitable for use by troops in the field.

APPROACH:

Maximize the efficiency of the G-76( )/G Direct Current Generator by studying physiological principles applicable to hand cranking, consider different gearing techniques as well as new magnet-coil-transformer-electronic processor designs. Study wind driven turbine design and adapt the principles developed during the previously described exercise to this means of driving the system.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1		100				
6.2		165	100			
6.3A			250			
6.3B						
6.4						
PIP						

COMMAND/PRIORITY:

ERADCOM/HDL/2

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

TITLE: *ELECTRONIC DEVICES RESEARCH*

SUBTITLE: RESEARCH ENERGY CONVERSION

OBJECTIVE AND EXPECTED PAYOFF:

The objective of this program is to analyze and solve the fundamental chemical and electrochemical problems which presently limit the development of more efficient, lighter weight and more cost effective primary and rechargeable batteries for use in a variety of Army applications.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

This project relates to Army Energy Goals and Objectives a(1).

STOG REFERENCE:

80-7.1:9

MAJOR TECHNOLOGICAL BARRIERS:

Work is being done on two types of systems, thionyl chloride, and on lithium sulfural chloride system. It is planned to overcome their shortcomings with regard to safety hazards and improving the stability of electrodes.

APPROACH:

Involves utilization of lithium as the negative plate material in battery cells.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.1	1L1.6.11.02AH4703	320	310	320	320	320	320

COMMAND/PRIORITY:

ERADCOM/180

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

TITLE: ELECTRONICS & ELECTRONIC DEVICES

SUBTITLE: POWER SOURCES & SUBSYSTEMS

OBJECTIVE AND EXPECTED PAYOFF:

Develop small, lightweight high energy batteries and silent portable power sources to meet critical forward area requirements of new equipments. Includes development of (1) high energy lithium batteries to overcome the deficiencies of present batteries and be compatible for use with laser designators (LWLD, GLLD), rangefinders (GVS-5), night sights (PAS-7), TOW Dragon, DMD, and SINCGARS; (2) high energy density rechargeable batteries with good cycle life to replace heavier nickel-cadmium batteries required for aircraft, combat vehicles and switchboards, (3) thermoelectric generators to provide silent, maintenance-free tactical power sources to satisfy SLEEP ROC and replace noisy, unreliable generators; and (4) advanced power processing techniques with high power density to meet system requirements of digital equipments (TACFIRE, FIREFINDER). Foreign intelligence information will be evaluated and considered in this program. Continue priority support to other laboratories and PM's. This program is the only one in the Army supporting AMC regulation.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

This project relates to Army Energy Goals and Objectives a(1).

STOG REFERENCE:

80-7.1:9

MAJOR TECHNOLOGICAL BARRIERS:

Major technological barriers involve trying to improve capability on lithium sulphur dioxide and trying to increase high rate capability to discharge safely at high rates, and to achieve good hermetic seals. In the secondary area of nickel zinc cells, effort is being spent on overcoming the barrier of shorting by zinc penetration.

APPROACH:

See objectives and expected payoff.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.2	1L1.6.27.05AH9411	739	650	880	900	1000	1000

COMMAND/PRIORITY:

ERADCOM/011

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

TITLE: ADVANCED TACTICAL POWER SOURCES

OBJECTIVE AND EXPECTED PAYOFF:

AMC Regulation 700-83 "Battery Power Sources" (being reissued as a DARCOM Regulation) assigns Army responsibility for battery research, development and engineering to ERADCOM. This is the only project on advanced development on batteries. It fulfills Army requirements for batteries for communications - electronics, mines, missiles, surveillance devices and aircraft. Power sources will be designed to satisfy the tactical and logistical requirements for long inactive shelf life, high energy density, continuous long life operation and high performance capabilities and enhancement of the Army's combat effectiveness. Provides standardized, precision, lightweight power generation/conversion systems to improve effectiveness, cost and survivability of highly mobile C-E systems.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

This project relates to Army Energy Goals and Objectives a(1).

STOG REFERENCE:

80-7.1:9

MAJOR TECHNOLOGICAL BARRIERS:

Major barrier involves designing and developing battery capability to meet all requirements for field use of equipments.

APPROACH:

See objectives and expected payoff.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84	FY85
6.3A	1L2.6.37.02DG10	861	1460	1300	1425	1425	1425

COMMAND/PRIORITY:

ERADCOM/041

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF:

Complete the development of training device for training artillery crews. Reduction of use of training ammunition and petroleum usage in live firing of artillery weapons.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

The US Army is presently spending over $100,000,000 annually for ammunition for training purposes. More importantly, the US Army is spending approximately $125,000,000 annually for fuels for going into the field for firing training purposes. The US Army Human Engineering Laboratory (HEL) has developed an Error Measuring Device for the 105mm and the 155mm (M109 Howitzer) which very accurately measures all of the gun lay errors at the time of firing. With minor modification, it can be con training device which, when installed on an artillery piece (ex., one per Battalion), and used even in the parking lot, will reduce the costs of live firing training by at least 75 percent.

STOG REFERENCE:

80 - 8.2 (30, 25 Energy Utilization)

MAJOR TECHNOLOGICAL BARRIERS:

None - the system has been designed - used twice in HELBAT VI and HELBAT VII. Both times equipment performed very successfully. Slight modification required in order to be used as a training device.

APPROACH:

Merely modify present system in order to serve as a training device.

FUNDING	DA PROJECT NUMBER	FY79 (Thous)	FY80* (Thous) 6.2
		10	Unknown

*If the artillery community endorses this system, and would want to procure sufficient quantities for all of US Army artillery units, the per unit cost is estimated to be $100,000 each.

COMMAND/PRIORITY:

USAHEL/1

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop technology for effective aerodynamic design and testing. Reduction of energy consumption through efficient development and production techniques.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Design missiles with contours that require less energy to produce.

STOG REFERENCE

80-8.2(30,25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Accomplishment of mission may have to be compromised through tradeoff studies between mission and energy reduction goals.

APPROACH

Missile aerodynamic configurations will be investigated with consideration given to simply generated shapes and contours consistent with aerodynamic efficiency.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162303A21405	0	50	400	0	0
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 2

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Application of new electronics technologies. Reduce fuel and energy consumption.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

DA Goals: a.2, c

STOG REFERENCE

80-8.2

MAJOR TECHNOLOGICAL BARRIERS

None

APPROACH

Conserve electricity by using advanced digital technology to replace older TTL-type chips in electronic equipment and designs with low power CMOS, HMOS, SOS-MOS I^2L, and LS integrated circuits. Replace older equipment (having tubes or discrete transistors) with new integrated low power equipment.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		100	100	200		
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 3

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Reduce energy loss associated with rejection of lined rocket motor case and the reclamation of metal parts.

DA GOAL SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA SUPPORTED

Reduce losses in energy-intensive rocket motor processing operations by 10 percent.

STOG-REFERENCE

4.1K

MAJOR TECHNOLOGICAL BARRIERS

The preparation, application and curing of liner for rocket motor cases is expensive in terms of both manpower and energy consumption. Further, the very limited shelf-life of lined motor cases demands further processing without regard to energy requirements, and increases the probability of loss of lined cases with the concomitant energy required to reclaim the metal parts. A technique to reduce such losses and at the same time permit optional scheduling of further processing is to use liners cured with blocked isocyanates. This type of cure will greatly extend the shelf-life of lined rocket motor cases.

APPROACH

Blocked isocyanate liners are being investigated under a separate R&D task, and the feasibility of their use will be demonstrated in that effort.

FUNDING	DA PROJECT NUMBER	FY80	FY81
6.1			
6.2	1L162303A214DB	100	100

COMMAND/PRIORITY

MICOM - 4

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Development of high energy electric discharge laser close cycle circulator to reduce size and weight of future system there by having minimum petroleum usage and associated cost.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in mobility operations by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

STOG REFERENCE

80-8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Presently, pulsed electric discharge lasers are vented to the atmosphere after the light energy is extracted. Need to be able to recirculate the gas.

APPROACH

- Determine the poisons in the laser gas.
- Develop a scrubber to clean up the laser gas.
- Determine efficient means of cooling the laser gas.
- Develop acoustic attenuator to reduce the shock waves in the laser gas.
- Develop the best flow techniques to get the maximum energy out of the laser gas.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	IL162307A139	250				
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 5

DRSMI-TDS (R&D)

OBJECTIVE AND EXPECTED PAYOFF

Utilizing high resolution thermal sensing devices/equipment, develop capability for studying/examining components, subsystems, systems, and structures to determine thermal emission patterns under operational conditions. Data can be used to compare heat loss as various modifications are made.

DA GOAL(S) SUPPORTED AND DOD ENERGY INTEREST AREA(S) SUPPORTED

Reduction of energy consumption due to heat loss of operational equipment by 10 percent by FY90.

STOG REFERENCE

80-8.2 (30,25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Development of small compact portable high resolution thermal sensing equipment.

APPROACH

- Develop capability for studying/examining components, subsystems, systems and structures to determine thermal emission patterns.
- Develop small compact portable high resolution thermal sensing devices/equipment.
- Develop techniques for studying thermal emission patterns of operational equipments.
- Develop data reduction and interpretation techniques.
- Develop standard procedures and incorporate into engineering development and production processes.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.2	1L123456X900745678	75	200	300	150	150

COMMAND/PRIORITY

MICOM - 6

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Missile energy use from manufacturer to field use.

DA GOAL(S) SUPPORTED AND DOD ENERGY INTEREST AREA(S) SUPPORTED

Reduce energy consumption, determine the use of fuel energy from manufacturing to field use and study the replacement by solar or other energy sources.

STOG REFERENCE

Unknown.

APPROACH

Energy is used from manufacturer to field use in various forms. The objective of this study would be a thorough analysis of the climatic conditions for potential savings of energy. This investigation would include the potential for use of solar energy to reduce fuel consumption.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1	Unfunded	50K				
6.2						
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 7

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERTIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Fuel consumption reduction in diesel engines.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce fuel consumption by making a more efficient/lighter weight diesel engine through use of lasers in fabrication.

STOG REFERENCE

Unknown.

MAJOR TECHNOLOGICAL BARRIERS

MERADCOM has an active program in research on the Adiabatic Diesel Engine, which if successful, will greatly reduce fuel consumption and decrease weight. A barrier problem is the requirement for ceramic coatings on pistons and cylinders. Attempts to coat with Si N are frustrated by the high temperatures required.

APPROACH

MERADCOM has pioneered laser photochemical production of Si N and should attempt to spin off this technology in cooperation with MERADCOM.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1	Unfunded	100K	200K	500K		
6.2						
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM - 8

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Reduce the hardware test requirements by coordination or simulation and test results. Reduce electrical power requirements for the simulation facilities.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce re-testing, duplication of simulations by 50 percent by year 1985.
Reduce electrical energy consumed by 15 percent.

STOG REFERENCE

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Development of rapid and efficient data storage and retrieval system with sufficient versatility to satisfy R&D type data environments.

APPROACH

Techniques for maximizing the efficiency of the use of simulation facilities will be investigated which will reduce the overall power requirements of machine operation. These areas include:

- Use of machines during off peak loading times.

- Statistical design of computer tests in the same manner as flight test programs would be designed to minimize the number of runs required.

- Improved data storage, retrieval, and analysis techniques to reduce the number of reruns required, and eliminate possible duplication of computer studies.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		25K	30K	50K	60K	60K
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/9

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Missile Technology - Develop nonmetallic composite structural applications to missile systems where total energy content for material and fabrication is less than in current practice.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in mobility operations.

MAJOR TECHNOLOGICAL BARRIERS

None.

APPROACH

Total energy required to make missile structures of polymeric materials is less than that for aluminum, steel, and other metals. Design applications and analytical techniques will be developed to encourage the use of these materials in lieu of metals.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1	1L162303A214	255K	250K	250K	275K	300K
6.2						
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/10

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Reduce fuel consumption in the fabrication and operational realm by virtue of reduced volume, weight and power consumption of the gyro in lieu of higher energy consumption metal - machining processes.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in mobility operation by 10 percent by FY85 with zero growth to the year 2000 with no degradation to readiness.

STOG REFERENCE

80 -8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Develop narrow line laser diodes, deposited wave guide technique with low loss. Also develop couplers and frequency shifting techniques.

APPROACH

Technique for fabrication of solid-state ring laser gyros are being developed to enable reduced volume, cost, and energy consumption. Techniques being developed would reduce the quantity of energy consumed during the fabrication of a gyro. Also, operational energy and volume reduction would permit lower flight fuel consumption by virtue of the reduced gross weight.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1		250K	250K	500K		
6.2						
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/11

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Utilize less total energy than current techniques use during heat treating and thermomechanical processing of metallic missile system structural components.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in facilities operations by 25 percent by FY85 and 50 percent by the year 2000.

STOG REFERENCE

80-8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Shortening of heat treatment cycles through prior and/or concurrent plastic deformation has shown limited potential.

An increased understanding of dynamic strain aging phenomena during the past 10 years provides a basis for further development of these procedures.

APPROACH

Emphasis will be placed on development of rapid heat treatment cycles, cyclic heat treatment, multistage heat treatment, shortening of heat treatment cycles through prior and/or concurrent plastic deformation and energy efficient thermomechanical strengthening procedures for steels and aluminum alloys. Evaluation will be based on strength, fracture toughness, dynamic fracture, and stress corrosion resistance properties obtained as a function of energy consumption.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	Unfunded	225K	250K	200K		
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/12

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop low power consumption digital logic for implementation of signal/data processors in Army ground-based sensors. Low power consumption will reduce petroleum requirements of prime power generators.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in mobility operations by 10 percent by 1985. Increase efficiency of nonrenewable energy-dependent mobility systems by 15 percent.

STOG REFERENCE

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Development of digital integration circuits with low power requirements but without a decrease in operating speed or device density.

APPROACH

Develop low power digital logic for ground-based sensors by:

- Analyzing system requirements on logic of sensor processors.
- Determining candidate technologies such as CMOS or SOS.
- Fabricating digital logic suitable for sensor processing.
- Breadboarding and demonstrating a low power sensor signal processor.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		90K	500K	800K	300K	100K
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/13

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Utilization of off-peak hours electricity generation. Reduction of total power consumption and cost.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

DA goals: a.1, a.2, b.1, c

STOG REFERENCE

80-8.2

MAJOR TECHNOLOGICAL BARRIERS

Development of low cost sensors.

APPROACH

Apply digital technology (including microprocessors) to energy management in military systems with the use of sensors, actuators, and timing. Investigate the scheduling and purchase of electrical power from off-base grids at off-peak prices, the rescheduling of power-intensive military operations to off-peak hours, and the storage of off-peak hour electricity, e.g., purchasing electric cars and charging their batteries at night and on weekends.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		100	200	200	200	100
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/14

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop the technology needed to optimize vehicle engine efficiencies at all times. Reduction of petroleum usage and associated cost.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

DA Goals: a.1, b.3, c. DOD special interest areas: 6

STOG REFERENCE

80-8.2, 80-3.2, 80-3.12

MAJOR TECHNOLOGICAL BARRIERS

Development of low cost sensors.

APPROACH

Utilize digital technology (microprocessors), sensors, and actuators to keep vehicles, and especially engines, in perfect tune and operating at optimal efficiency at all times, e.g., develop a fuel management system for helicopters similar to those now in use in commercial aircraft.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		100	300	500	300	200
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/15

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop the technology for effective utilization of vortex tube devices for temperature control of missile inertial components. Reduce energy consumption by utilizing available compressed gas as an energy source in lieu of electrical energy.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in mobility operations by 10 percent. Expand energy conservation education/information and incentive programs.

STOG REFERENCE

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Development of vortex tube devices and applications techniques to allow component cooling in missile systems by using available on-board compressed gas as a source.

APPROACH

Develop vortex tube application techniques for missile systems components:

- Determine temperature control requirements for components.
- Design configuration for application of vortex tube.
- Evaluate trade-off of using compressed gas versus electrical energy as a source.
- Evaluate commercial items and determine cost to apply.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2		100	100			
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/16

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop design approaches for wind tunnel models and instrumentation to minimize tunnel operating time. Pay-off is reduction of tunnel electric power requirements for a particular project.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in facilities operation.

STOG REFERENCE

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

No technological barrier. Increased design time and fabrication costs for the test hardware will be required.

APPROACH

- Develop a general program to provide a comparison between the time and costs incurred to use remotely controlled wind tunnel models and the energy savings realized.

- Develop multipurpose model components that can be incorporated into specific models to reduce wind tunnel operating time which reduces energy requirements.

- Survey energy consumption of wind tunnels utilized by the Army and develop analytical tools to provide trade-off between model design and facility to minimize energy usage.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162303A21405	80	75	75		
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/17

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop method for transferring from mobile generators to commercial power for testing of repetitive pulsed electric discharge lasers. Reduction in fuel usage and reduced maintenance cost.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Save fuel by only operating mobile generating equipment at the most efficient loading.

STOG REFERENCE

80-8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Fast startup of large power generating equipment.

APPROACH

Develop fast startup, high power generating equipment and transfer system to start and transfer the load from commercial power to mobile generators for actual operation of the system.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2						
6.3A						
6.3B						
6.4						
PIP		100K Unfunded	100K Unfunded			

COMMAND/PRIORITY

MICOM/18

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Develop techniques for maintaining computing efficiency while reducing consumption of energy by peripheral equipment (card readers, tape drives, printers, etc.) when not being utilized (switching equipment on/off automatically).

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduce energy consumption in facilities operating by 25 percent by FY85 and 50 percent by the year 2000.

STOG REFERENCE

80 - 8.2 (30, 25) Energy Utilization

MAJOR TECHNOLOGICAL BARRIERS

Development of hardware (fast warmup and high speed switching components) and software techniques for automatic on/off operations.

APPROACH

Develop energy efficient computer peripheral equipment:
- Analyze percentage of time peripheral equipment is used versus "on" time and determine realistic needs.
- Survey commercial market for available systems and/or components suitable for automatic on/off operation.
- Evaluate commercial items (if available) and estimate cost.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2	1L162303A214	30	150	150	100	50
6.3A						
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

MICOM/19

APPENDIX A
SECTION 7. EQUIPMENT COMPONENT DEVELOPMENT

ARMY ENERGY R&D PROGRAM FOR MOBILITY OPERATIONS
PRIORITIZED COMMAND OBJECTIVE

OBJECTIVE AND EXPECTED PAYOFF

Replace high power vacuum tube amplifiers in vibration test equipment with solid state amplifiers. Reduction of electrical power consumption.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED

Reduction of electrical power consumption by modernizing power amplifiers.

STOG REFERENCE

80-8.2 (20, 25) Energy Utilization.

MAJOR TECHNOLOGICAL BARRIERS

None, high power solid state amplifiers are currently available commercially.

APPROACH

- Analyze power requirements of existing 12 kW, 45 kW, 120 kW, 140 kW, and 175 kW amplifiers as compared with solid-state amplifiers.
- Survey market for replacements compatible with existing equipment.
- Replace vacuum tube amplifiers with efficient solid-state amplifiers as funds become available.

FUNDING	DA PROJECT NUMBER	FY80	FY81	FY82	FY83	FY84
6.1						
6.2						
6.3A	Unfunded	50K	500K			
6.3B						
6.4						
PIP						

COMMAND/PRIORITY

APPENDIX B

SELECTED MOBILITY ENERGY PROGRAMS

SECTION 1. GASOHOL PROGRAM

SECTION 2. ARMY MOBILITY FUELS PROGRAM

SECTION 3. ENGINE DEVELOPMENT - TARADCOM

SECTION 4. ENGINE DEVELOPMENT - AVRADCOM

SECTION 5. ENGINE DEVELOPMENT - MERADCOM

SECTION 1. GASOHOL PROGRAM

SECTION 1. GASOHOL PROGRAM

The US Army Mobility Equipment Research and Development Command (MERADCOM) has initiated a pilot program as the first phase in the Army GASOHOL Program. The purpose of this program is to evaluate the use of GASOHOL* (a mixture of 90% gasoline and 10% ethyl alcohol) in Army tactical vehicles and equipment. While focusing on tactical vehicles and equipment, the Army's GASOHOL Program is cooperating with other state, local, and DOE sponsored GASOHOL evaluation programs nationwide whose purpose is to reduce the consumption of gasoline in this country. The Army still employs a variety of gasoline powered tactical vehicles including the M151 1/4 ton utility truck (Jeep) and the M880 1-1/4 ton utility truck. Also, there are many specialized pieces of gasoline powered tactical equipment utilizing Military Standard Engines such as generator sets and pumps.

The MERADCOM program will include chemical compatibility tests, GASOHOL analysis tests, static engine tests, and fleet tests. The compatibility tests will determine the effects of alcohol and GASOHOL on materials used in tactical fueling systems, vehicles and equipment, especially the elastomeric materials. GASOHOL analysis tests will include the development of a field kit to determine the alcohol content in GASOHOL. Static engine tests will make use of Military Standard Engines under controlled conditions to determine the effect of GASOHOL on performance, reliability, fuel consumption, and engine life. The fleet tests will consist of the use of GASOHOL in all MERADCOM vehicles and equipment. Drivers and maintenance personnel will be surveyed using

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*Trademark registered by Nebraska Agricultural Products Industrial Utilization Committee

questionnaires. Concurrently, a draft procurement specification will be prepared for military procurement of GASOHOL when it becomes generally available.

The MERADCOM fleet test will be used principally to define problem areas in the procurement, distribution, and use of GASOHOL in tactical vehicles and equipment. These problems will be answered when the program is expanded to other military bases that will make use of a greater number and variety of tactical vehicles in a variety of geographic and climatic conditions. These bases are Fort Belvoir, VA; Letterkenny Army Depot, PA; Red River Army Depot, TX; and Fort Lewis, WA. Controlled fleet tests will be run at these locations using preselected identical pairs of tactical vehicles - half run on GASOHOL and the other half on unleaded gasoline. Later, all of the gasoline powered vehicles at the bases will be run on GASOHOL, exclusively. Information gathered from these controlled fleet tests, along with the results of MERADCOM's program, will allow MERADCOM to determine the effect of GASOHOL on Army tactical vehicles and equipment under a variety of conditions.

TECHNICAL ASPECTS OF THE ARMY GASOHOL PROGRAM

The GASOHOL that will be used in the initial phase of the Army GASOHOL Program was prepared by blending nine parts of commercial unleaded gasoline with one part of denatured ethyl alcohol (ethanol). The ethyl alcohol is a minimum of 199 proof (99.5% ethyl alcohol) and meets the requirements of the Bureau of Alcohol, Tobacco, and Firearms (BATF) Formula No. 19 describing completely denatured alcohol. The denaturing formula is as follows: 100 parts ethyl alcohol, 4 parts methyl isobutyl ketone, one part gasoline or kersene.

The alcohol was procured by competitive bidding with ADM Corn Sweetners, Decatur, IL; the low bidder and supplier. Future purchases of alcohol will be made in the same way and should meet the requirements of Formula No. 19 or

Formula No. 20. Formula 20, which has not been officially approved by the BATF, only requires the use of gasoline as a denaturant and should be cheaper and be less damaging to elastomeric materials. Procurements of alcohol by the Army is considered an interim measure only. Direct purchase of GASOHOL from commercial sources is preferrable and will be made when GASOHOL becomes more generally available. A military procurement specification for GASOHOL will be prepared by MERADCOM based upon the results of the MERADCOM phase of the Army GASOHOL Program.

OUTLINE OF GASOHOL EVALUATION

1. STORAGE EFFECT ON GASOHOL

   a. Monitor Supply - assure clean storage tanks and fuel transfer equipment.

   b. Long-term (i.e., 3 to 6 months or more) storage tests in Army collapsible tanks.

   c. Fuels stored in vehicle fuel tanks (administrative type storage, vehicles awaiting repairs, etc.).

2. MATERIALS COMPATIBILITY

   a. Engine Components
   b. Engine fuel system components
   c. Fuel handling equipment components

3. ENGINE DYNAMONETER TESTING
   (210-hour Wheeled Vehicle Cycle)

   a. LDT 465 - Multifuel Engine
   b. Army Design - M-151 Engine
   c. 75M - M577-M113
   d. Dodge M880 1-1/4 Ton

4. CONTROLLED FLEET TESTING

New vehicles if possible; in the event not possible, vehicles will have pre-test inspection and tune-up to establish baseline performance. Sites selected to evaluate effects of climate and geographical location are as follows:

a. FORT BELVOIR

1. PHASE I - 20 vehicles
   (a) Engine oil A
   (b) Engine oil B

2. PHASE II - TOTAL GASOLINE POWERED FLEET

b. MERADCOM - TOTAL GASOLINE POWERED FLEET

c. LETTERKENNY ARMY DEPOT

1. PHASE I - 20 Vehicles
   (a) Engine Oil A
   (b) Engine Oil B

2. PHASE II - TOTAL GASOLINE POWERED FLEET

d. FT. LEWIS

1. PHASE I - 20 Vehicles
   (a) Engine Oil A
   (b) Engine Oil B

2. PHASE II - TOTAL GASOLINE POWERED FLEET

e. RED RIVER ARMY DEPOT (Army Energy Showcase)

1. PHASE I - 20 Vehicles
   (a) Engine Oil A
   (b) Engine Oil B

2. PHASE II - TOTAL GASOLINE POWERED FLEET

5. OTHER ARMY EQUIPMENT

a. MIL-STD-GENERATORS
1. - 4 - CONTROL
2. - 4 - UNLEADED GASOHOL

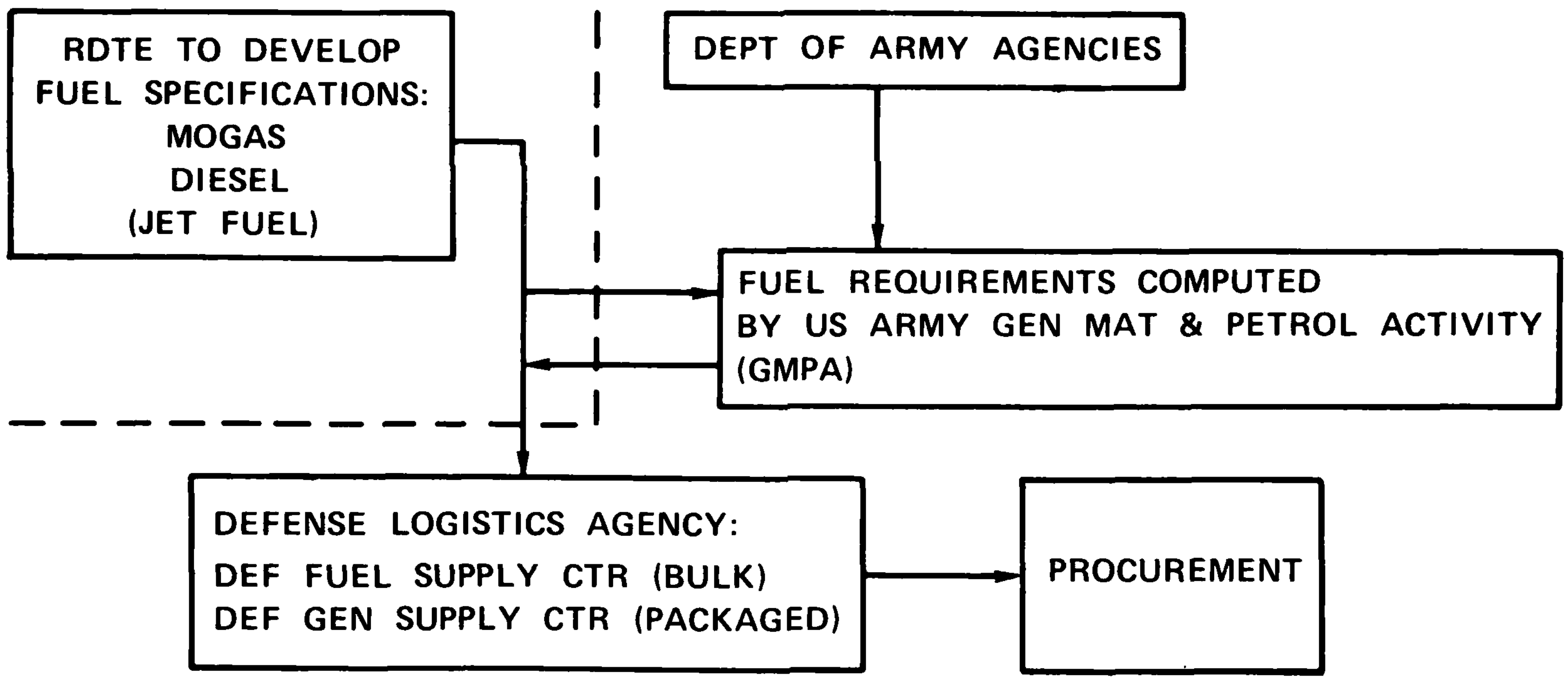
b. HEATERS, OUTBOARD MOTORS, etc.

SECTION 2. ARMY MOBILITY FUELS PROGRAM

SECTION 2.
ARMY MOBILITY
FUELS PROGRAM

ARMY MOBILITY FUELS

DEVELOPMENT - IMPLEMENTATION - PROCUREMENT



ENGINE SYSTEMS USED IN ARMY GROUND & AVIATION EQUIPMENT

SPARK-IGNITION

TWO-CYCLE	AIR-COOLED	NORMALLY-ASPIRATED
TWO-CYCLE	LIQUID-COOLED	NORMALLY-ASPIRATED (MARINE APPLICATION)
FOUR-CYCLE	LIQUID-COOLED	NORMALLY-ASPIRATED
FOUR-CYCLE	AIR-COOLED	NORMALLY-ASPIRATED AND TURBOCHARGED (MARINE AND AVIATION APPLICATIONS)

COMPRESSION-IGNITION

TWO-CYCLE	LIQUID-COOLED	NORMALLY-ASPIRATED AND TURBOCHARGED
FOUR-CYCLE	LIQUID-COOLED	NORMALLY-ASPIRATED, TURBOCHARGED AND MULTIFUEL
FOUR-CYCLE	AIR-COOLED	TURBOCHARGED

GAS TURBINE

GAS TURBINE	TURBO-SHAFT/ TURBO-PROP	AVIATION AND GROUND

PRIMARY ARMY MOBILE FUELS

	COMBAT		ADMINISTRATIVE	
FUEL	MIL SPEC	NATO DESIGNATION	FED SPEC	INDUSTRY STD
AUTOMOTIVE GASOLINE	MIL-G-3056D	F-46	VV-G-1690B	ASTM D439
JET TURBINE FUEL	MIL-T-5624H	F-40/F-44	MIL-T-5624K	ASTM D1655
	MIL-T-83133	F-34	MIL-T-5624K	ASTM D1655
DIESEL FUEL	VV-F-800B	F-54	VV-F-800B	ASTM D975

ARMY MOBILITY FUELS AND FUELS RELATED RDTE

GROUND EQUIPMENT

TARADCOM

- ENGINE DEVELOPMENT
- INVESTIGATE MULTIFUEL ENGINE CAPABILITIES
- ENGINE QUALIFICATION

AVIATION EQUIPMENT

AVRADCOM

- ENGINE DEVELOPMENT
- INVESTIGATE MULTIFUEL ENGINE CAPABILITIES
- ENGINE QUALIFICATION AND AIRWORTHINESS

MERADCOM

- FUELS TECHNOLOGY AND SPECIFICATION DEV.
- FUEL HANDLING EQUIPMENT TECHNOLOGY
- GROUND SUPPORT EQUIPMENT TECHNOLOGY

READINESS COMMANDS INVOLVED: TSARCOM AND TARCOM

ARMY MOBILITY FUELS PROGRAM
COORDINATION ACTIVITIES

- JLC'S JOINT TECHNICAL COORDINATING GROUP – AIRCRAFT SURVIVABILITY
- COORDINATION GROUP ON GOVERNMENT AVIATION FUELS RDTE (DOD, NASA, AND DOT)
- AVRADCOM/TARADCOM/MERADCOM SEMI-ANNUAL TECHNICAL PROGRAM INTERCHANGE
- FEDERAL AD HOC INTERAGENCY COMMITTEE ON ALCOHOL FUELS
- NATO MILITARY AGENCY FOR STANDARDIZATION'S ARMY, AIR, AND NAVAL FUELS AND LUBRICANTS WORKING PARTIES
- AIR STANDARDIZATION COORDINATING COMMITTEE WORKING PARTY 15 – FUELS AND LUBRICANTS

PRINCIPAL AREAS OF POL RESPONSIBILITIES

FUELS

	ARMY	NAVY	AIR FORCE
MOTOR GASOLINE	LEAD*	–	–
AVIATION GASOLINE	–	LEAD	–
TURBINE FUEL			
JP-4 & JP-8	–	–	LEAD
JP-5	–	LEAD	–
DIESEL FUEL			
MARINE (DF-M)	–	LEAD	–
REGULAR (DF-2, NATO F-54)	LEAD	–	–
DISTILLATE FUEL OIL			
HEATING OIL	LEAD	–	–
NAVY SPECIAL	–	LEAD	–

*"LEAD" IDENTIFIES CUSTODIAL RESPONSIBILITY FOR SPECIFICATION PRODUCT IN QUESTION AND FOCAL POINT WITHIN DOD.

ARMY MOBILITY FUELS PROGRAM

MAJOR THRUSTS

- DEVELOP CAPABILITY FOR USING SYNTHETIC AND ALTERNATIVE FUELS
- DEVELOP SPECIAL PURPOSE FUELS – FIRE RESISTANT FUEL
  – HIGH ENERGY FUEL
- IMPROVE FUEL QUALITY AND STORAGEABILITY
- CONDUCT GASOHOL EVALUATION AND ISSUE SPECIFICATION
- DEVELOP NEW, ACCELERATED FUEL-ENGINE QUALIFICATION PROCEDURE(S) METHODOLOGY

FUNDING PROFILE

FUNDING PROFILE--MOBILITY FUELS RDTE

	FUNDED ($K)[1]						
	FY80	FY81	FY82	FY83	FY84	FY85	FY86
P.E. 61102A	(70)	(70)	(183)	(330)	(380)	(445)	(440)
FUEL MECHANISTIC STUDIES	70	70	85	85	75	85	80
INVESTIGATING FUEL DETERIORATION	–	–	98	75	70	80	80
SYNTHETIC FUEL COMBUSTION STUDIES	–	–	–	170	235	280	280
P.E. 62733A	(3039)	(2815)	(5000)	(5350)	(3000)	(1985)	(2218)
FIRE RESISTANT FUEL	500	500	100	100	100	100	100
ALTERNATIVE/SYNTHETIC FUELS	2239	2165	4570	4775	1950	935	1168
IMPROVED FUEL STABILITY	100	75	100	125	150	150	150
MILITARY ENGINE FUEL REQUIREMENTS	200	75	230	350	800	800	800

[1]FUNDS SHOWN EXCLUDE FUEL PROCUREMENT COST

FUNDING PROFILE—MOBILITY FUELS RDTE

	FUNDED ($K)[1]						
	FY80	FY81	FY82	FY83	FY84	FY85	FY86
P.E. 63104D							
FIRE-RESISTANT FUEL SYSTEM	500	500	—	—	—	—	—
MILITARY FUEL QUALITY MONITOR	—	—	200	—	—	—	—
GASOHOL EVALUATION	1095	—	—	—	—	—	—
USER ACCEPTANCE TESTING	—	200	200	1209	1053	1314	1386
P.E. 63726D							
FIRE-RESISTANT FUEL SYSTEM	-0-	475	514	116	-0-	-0-	-0-
P.E. 64717D							
FIRE-RESISTANT FUEL SYSTEM	-0-	-0-	-0-	800	425	200	200

[1] FUNDS SHOWN EXCLUDE FUEL PROCUREMENT COST

FUELS-RELATED DARCOM PROGRAMS

PE/TITLE	COMMAND	FY80	FY81	FY82	FY83	FY84
61102A/ ENZYMATIC HYDROLYSIS-CELLULOSE	NARADCOM	100	150	150	150	150
62601A/ ENGINE CONCEPTS-NON PETROLEUM FUELS	TARADCOM	-0-	900	1000	1500	1777
63201D/ IMPROVED HELICOPTER ENGINES (EVALUATE SYNTHETIC FUELS)	AVRADCOM	-0-	837	5661	9325	4595
MACI/ ALTERNATE FUELS FOR COMMERCIAL ENGINES	TARADCOM	400				
63621D/ ENGINE CONCEPTS-ALTERNATE FUELS	TARADCOM	-0-	-0-	300	3500	3500

TECHNICAL EFFORTS

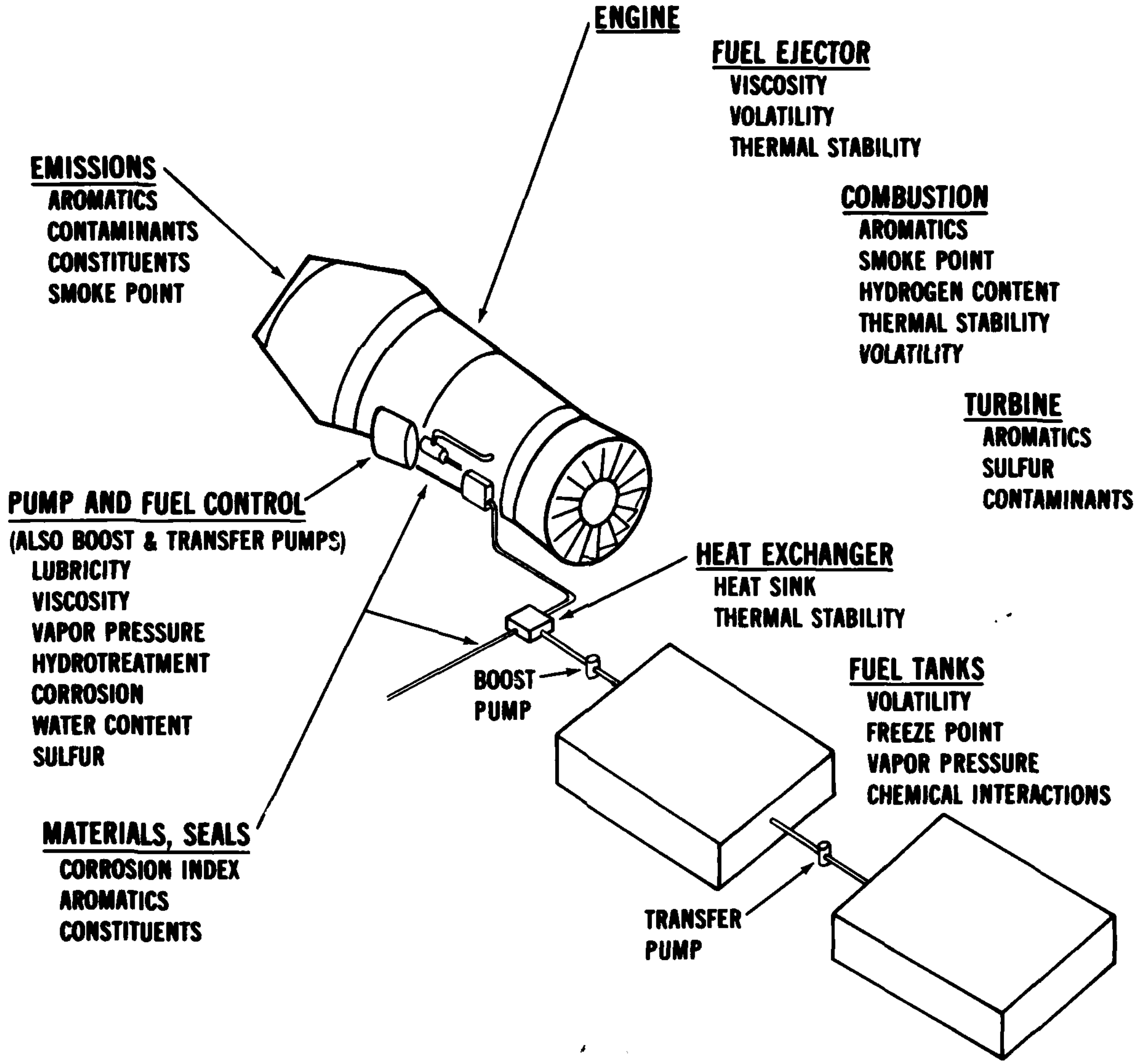
- FUEL/ENGINE RELATIONSHIPS AND REQUIREMENTS
- SYNTHETIC/ALTERNATIVE FUELS
- FIRE-RESISTANT FUEL
- GASOHOL
- HIGH ENERGY AND FUEL STABILITY

MOBILITY FUEL PERFORMANCE PROPERTIES

AREAS OF CONCERN – NEW OR MODIFIED FUELS

- ENGINE RESPONSIVENESS
  - COMBUSTION QUALITY (CETANE, OCTANE, LUMINOSITY)
  - EMISSIONS
- VOLATILITY & VISCOSITY QUALITIES FOR OPERABILITY
- COMPATIBILITY WITH –
  - METALS & NON-FERROUS MATERIALS
  - ELASTOMERS
  - PLASTICS
- POTENTIAL TOXICOLOGICAL HAZARDS
- MICROBIOLOGICAL SUSCEPTIBILITY
- IMPACT ON RAM-D FACTORS (WEAR TENDENCIES, DEPOSITS, ETC.)
- STORAGE STABILITY
- INTERCHANGEABILITY
- FILTERABILITY AND CLEANLINESS

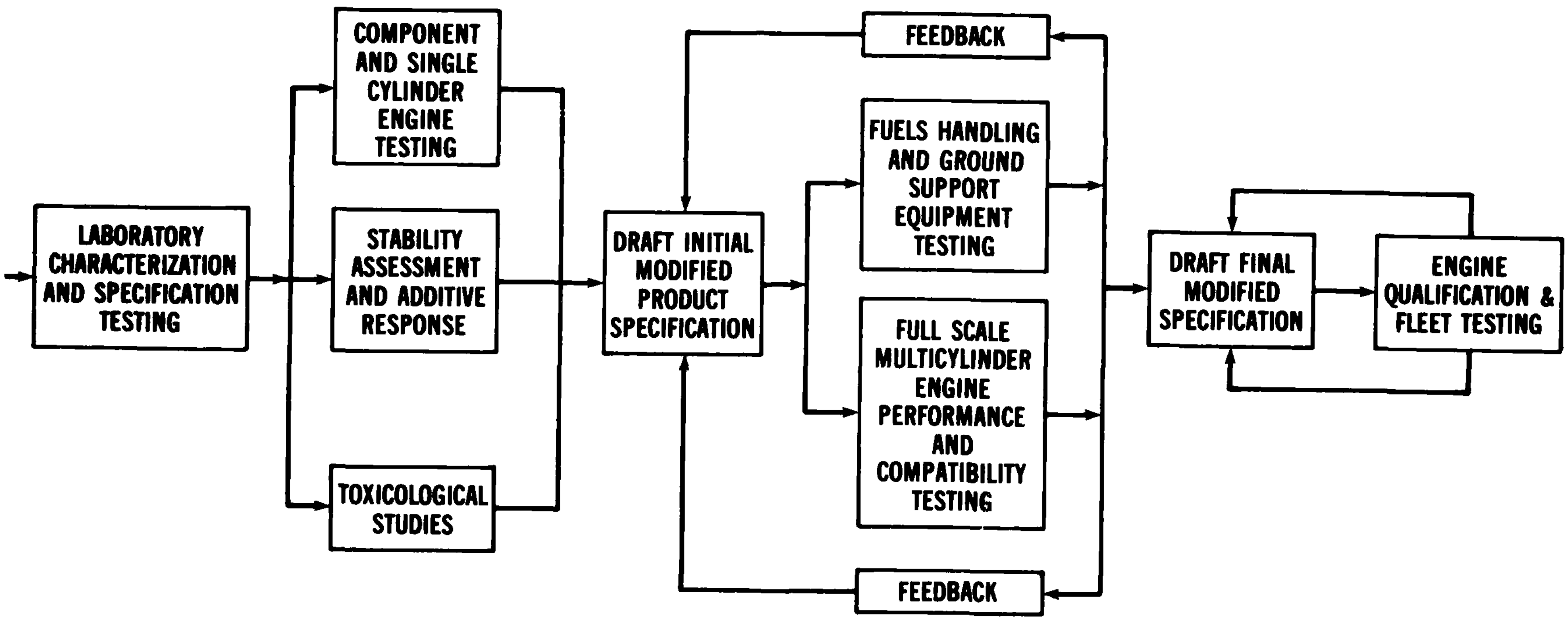
ENGINE-FUEL INTERFACE



FUEL SPECIFICATIONS PROVIDE AND/OR DEFINE FOLLOWING

- FUEL TYPE/CLASSIFICATION
- COMPOSITION
- PERFORMANCE REQUIREMENTS
- FUEL QUALITY
- INTENDED USE AND LIMITATIONS (GEOGRAPHICAL)
- STANDARDIZATION/INTERCHANGEABILITY
- PROCUREMENT

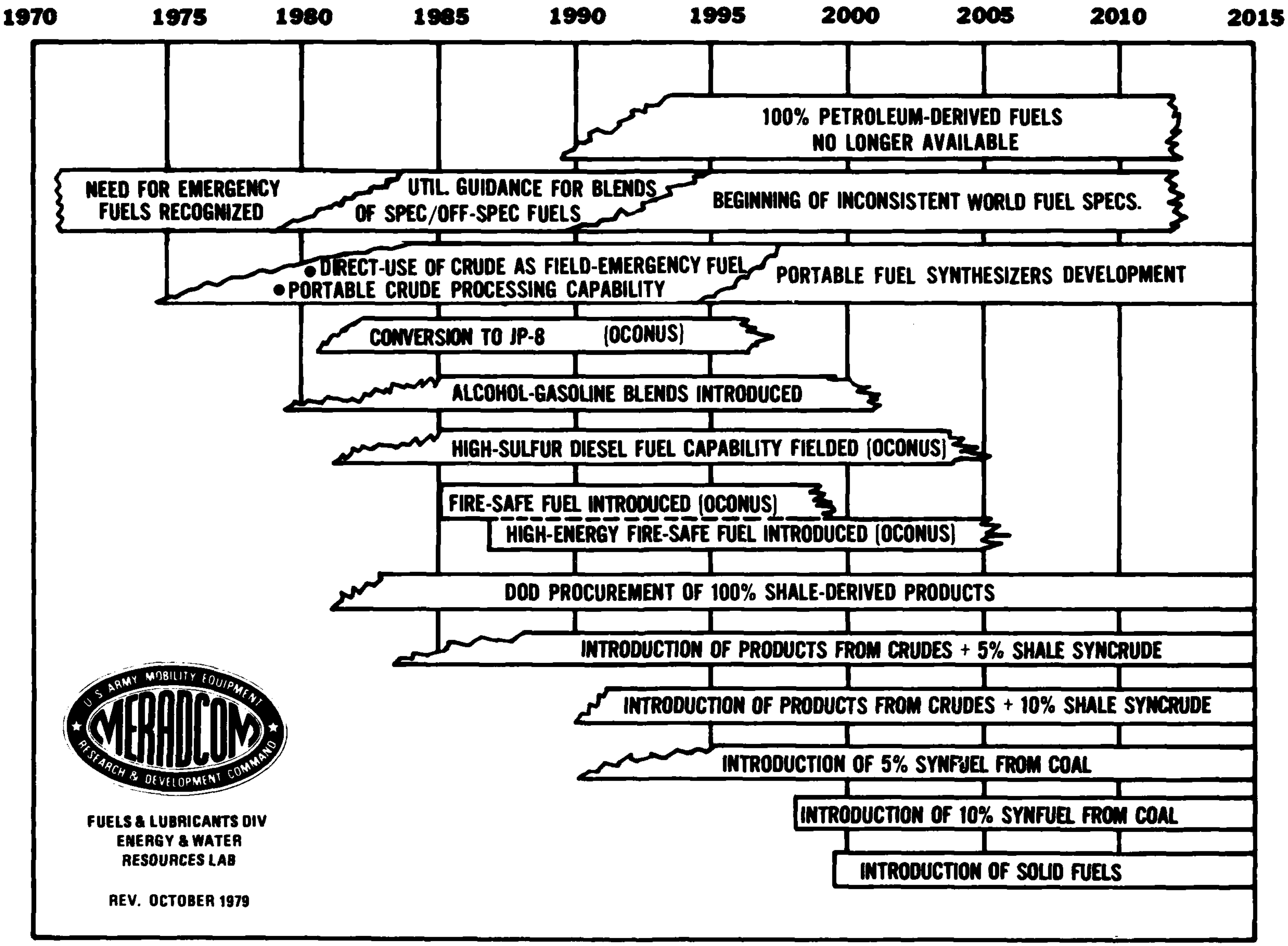
PROCESS FOR EVALUATING NEW/SYNTHETIC FUELS

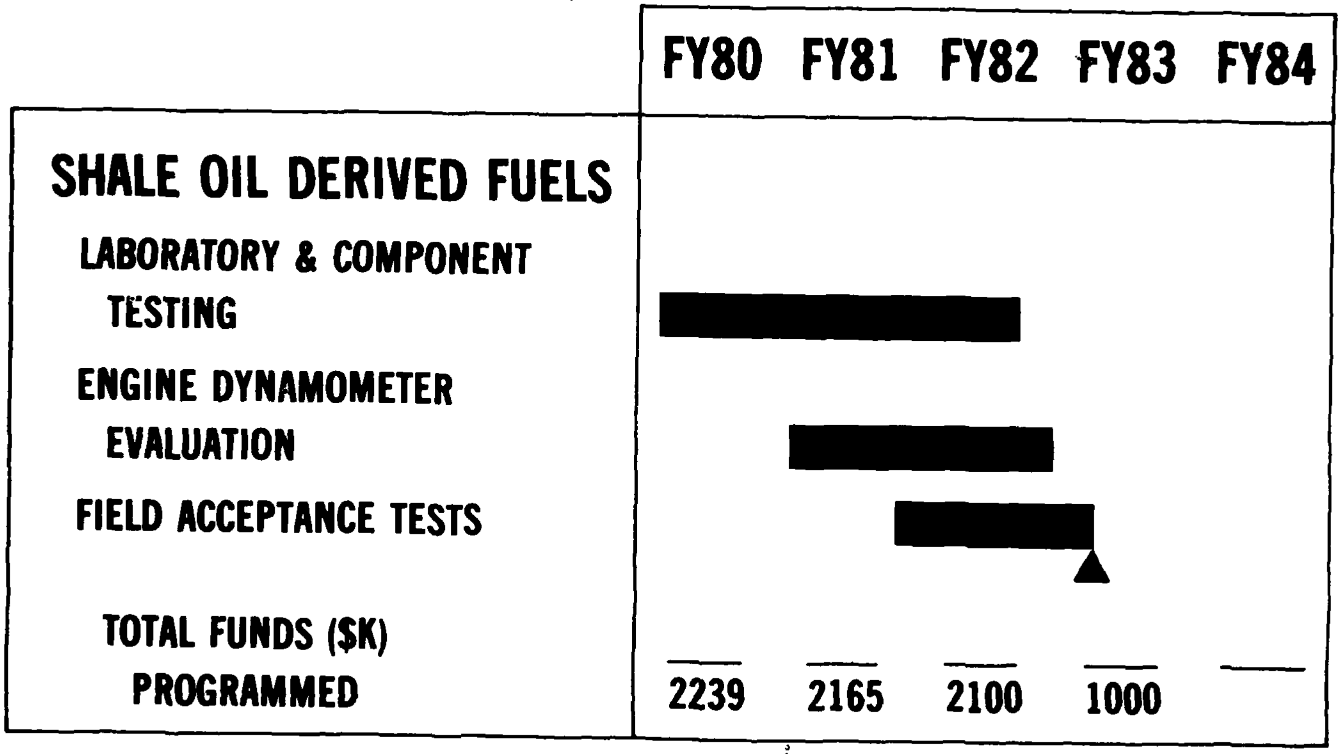


SYNTHETIC/ALTERNATIVE FUELS SCHEDULED FOR RDTE

TYPE	INITIATION OF RDTE
SHALE OIL DERIVED	
• ABOVE-GROUND RETORT	FY80
• IN-SITU OR MODIFIED IN-SITU RETORT	FY81/82
COAL LIQUEFACTION DERIVED	
• SOLVENT EXTRACTION	FY82
• DIRECT HYDROGENATION	?
• INDIRECT LIQUEFACTION	?
BIOMASS DERIVED (FUEL EXTENDERS)	
• ALCOHOLS (GASOHOL)	FY82-83 (FY80)
• VEGETABLE OILS (PALM, BABACU, SOYA)	
• WOOD	FY83

ARMY MOBILITY FUELS SCENARIO

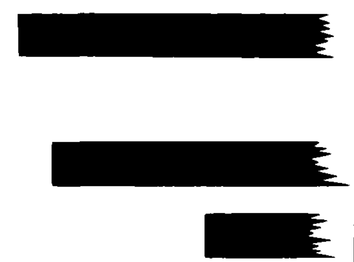




▲ – DEVELOPMENT OF FUEL SPECIFICATIONS FOR MOGAS AND DIESEL

	FY80	FY81	FY82	FY83	FY84
COAL LIQUEFIED FUELS					
LABORATORY & COMPONENT TESTING					
ENGINE DYNAMOMETER EVALUATION					
FIELD ACCEPTANCE TESTS					
TOTAL FUNDS ($K) PROGRAMMED	-0-	-0-	2470	3029	650

BIOMASS DERIVED FUELS	FY80	FY81	FY82	FY83	FY84
LABORATORY AND COMPONENT TESTING					
ENGINE DYNAMOMETER EVALUATION					
FIELD ACCEPTANCE TESTS					
TOTAL FUNDS ($K) PROGRAMMED	-0-	-0-	-0-	1255	950



WOOD AS POTENTIAL MOBILITY FUEL

- ARMY RSCH OFC TO ASSESS SCIENCE/TECHNOLOGY FOR OBTAINING MOBILITY FUELS FROM WOOD

- POSSIBLE APPROACHES MAY INVOLVE – LIQUIDS
  * PYROLYSIS/GASSIFICATION
  * PULVERIZING/SLURRIES
  * EXTRACTION
  * FERMENTATION

- CURRENT EFFORTS EXIST WITHIN DEPARTMENTS OF AGRICULTURE & ENERGY
  * DEPT OF AGRICULTURE – MOBILE PYROLYSIS UNIT PROSECT (ENERCO)
    – FOREST WASTE PELLETS (GUARANTY FUELS)
  * DEPT OF ENERGY – ALTERNATE FUELS UTILIZATION PROGRAM

PROJECTED SHALE OIL SYNFUEL FUEL REQUIREMENTS

	FY80		FY81	FY82
	bbls, delivered	bbls, required	bbls, required	bbls, required
AUTOMOTIVE GASOLINE	-0-	50	400	400
JET FUEL, JP-4	-0-	60	18,100	18,100
JET FUEL, JP-8	-0-	10	50	50
JET FUEL, JP-5	55	-0-	100	100
DIESEL FUEL	90	-0-	1,550	16,000

ENGINE TYPES & FUEL CONSUMPTION RATES

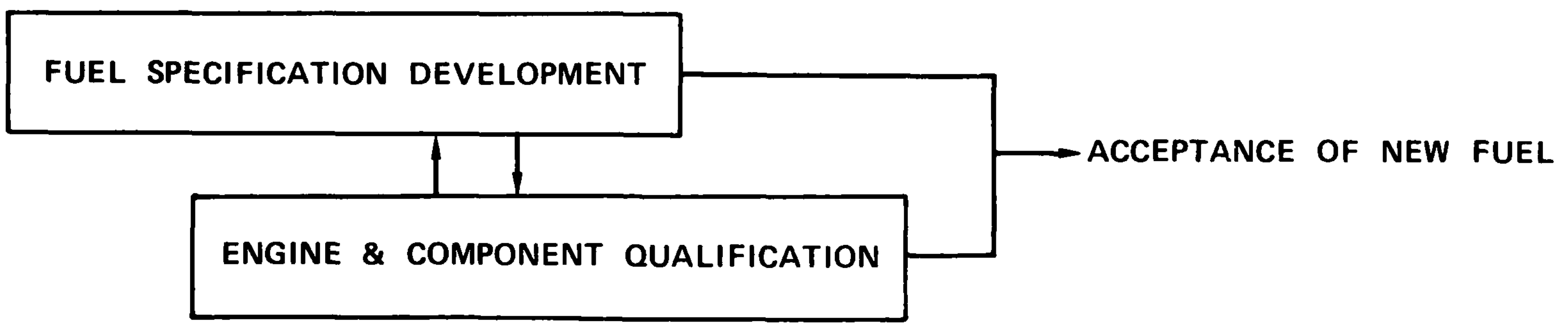
ENGINE	TYPE	VEHICLE/AIRCRAFT	RATE OF FUEL CONSUMPTION		TOTAL FUEL QUANTITY REQUIRED		
			mpg	gph	Gallons	Drums	(bbls)
HERCULES, L141	4 CYL, 4 CYCLE S.I.	TRUCK, UTILITY, 1/4-T, M-151	16	4	1,800	33	43
CONTINENTAL, LDT-465	6 CYL, 4 CYCLE C.I. (MANN SYSTEM)	TRUCK, CARGO, 2½-T, M34/M35	5	10	4,500	83	107
CUMMINS, NHC 250	6 CYL, 4 CYCLE C.I.	TRUCK, CARGO, 5-T, M-813	4.2	10.5	4,725	88	113
DETROIT DIESEL 6V53T	6 CYL, 2 CYCLE C.I.	ARMORED ASSAULT VEHICLE, M-551	1.9	15	6,750	125	161
CONTINENTAL, AVDS-1790-2C	12 CYL, 4 CYCLE C.I., AIR-COOLED	MAIN BATTLE TANK, M-60/M-48	0.7	40	18,000	333	429
AVCO-LYCOMING AGT-1500	GAS TURBINE, RECUPERATED	XM-1 TANK SYSTEM	0.54	46.3	46,300	857	1,102
GENERAL ELECTRIC T-700	GAS TURBINE, TURBOSHAFT	UTILITY HELICOPTER, UH-60A	–	81.7[1]	81,700	1,513	1,945

[1]RATED AT 1000 hp

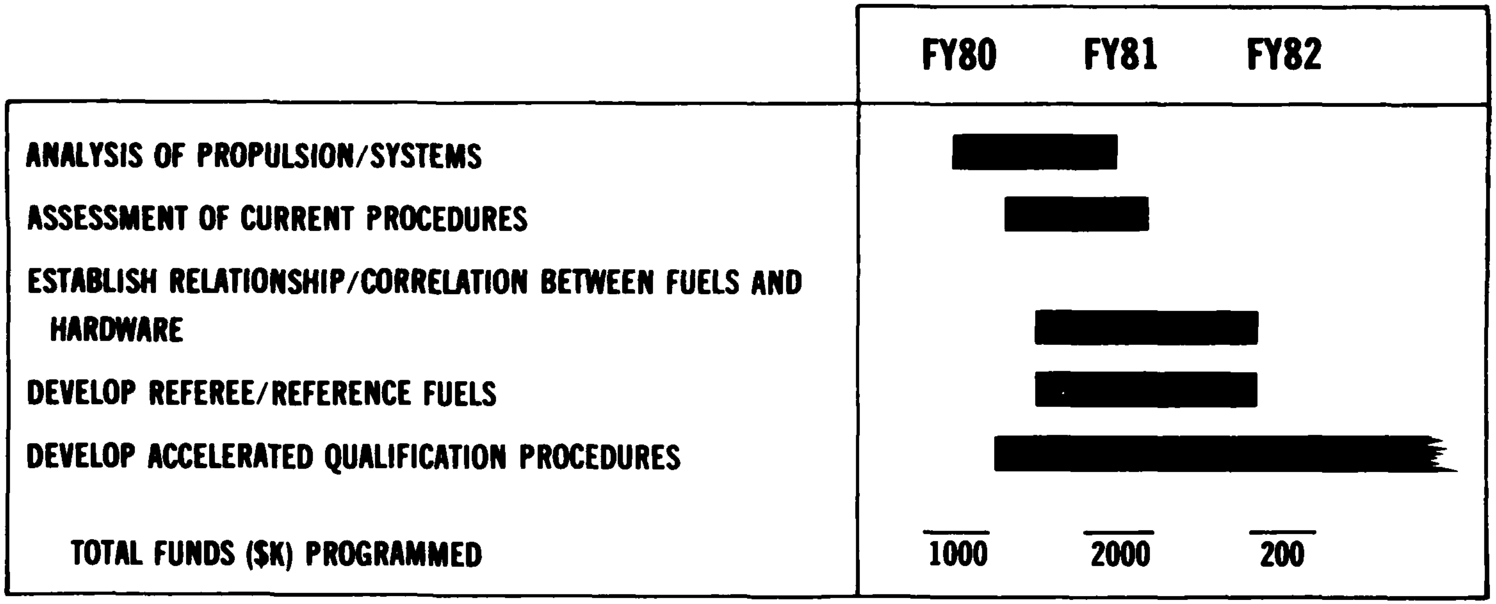
NOTE: FUEL QUANTITIES REFLECT RQMTS FOR SINGLE TESTS, 450 HRS FOR C.I./S.I. ENGINES & 1000 HRS FOR GAS TURBINE ENGINES

TASK: DEVELOP MORE EFFICIENT MILITARY FUEL QUALIFICATION PROCEDURES TO EFFECT CAPACITY TO REACT QUICKLY TO CHANGES ENCOUNTERED IN PETROLEUM REFINING INDUSTRY

CURRENT SYSTEM INVOLVES:



ACCELERATED FUEL-ENGINE QUALIFICATION PROCEDURE(S) METHODOLOGY



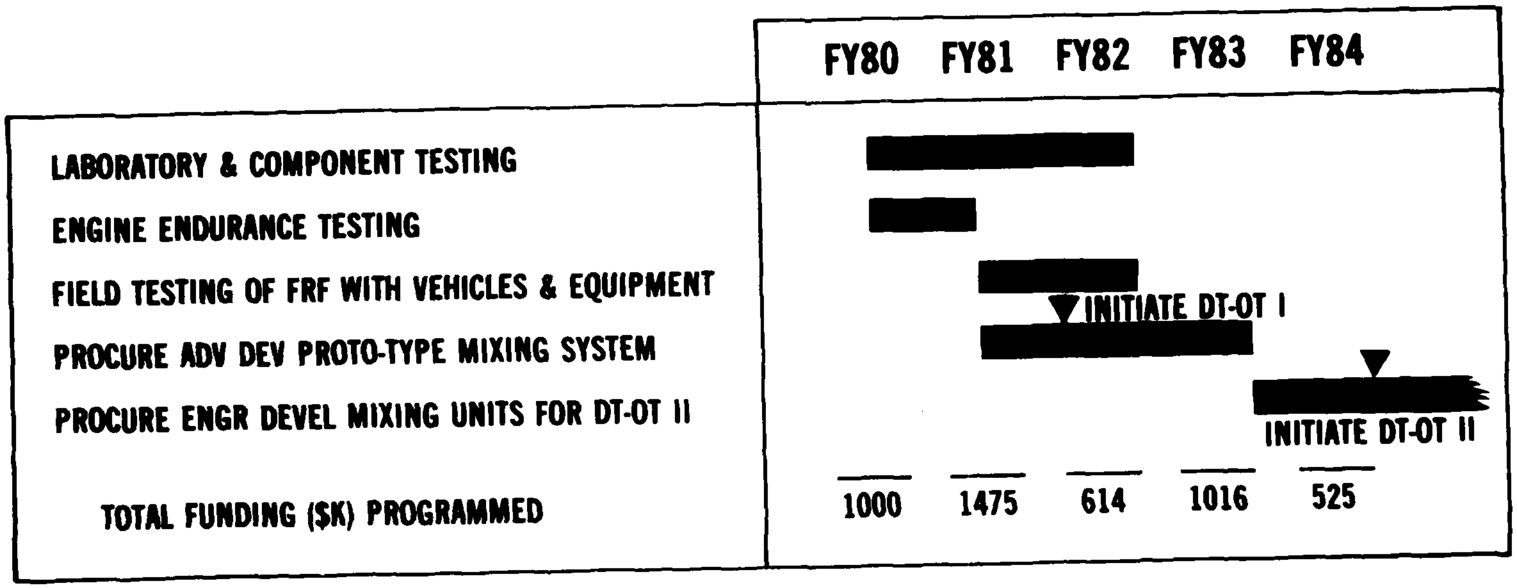
FIRE-RESISTANT FUEL (FRF) SYSTEM

- TRADOC REQUIREMENT REVIEW BOARD RECOMMENDED APPROVAL OF LOA ON 14 FEBRUARY 1980

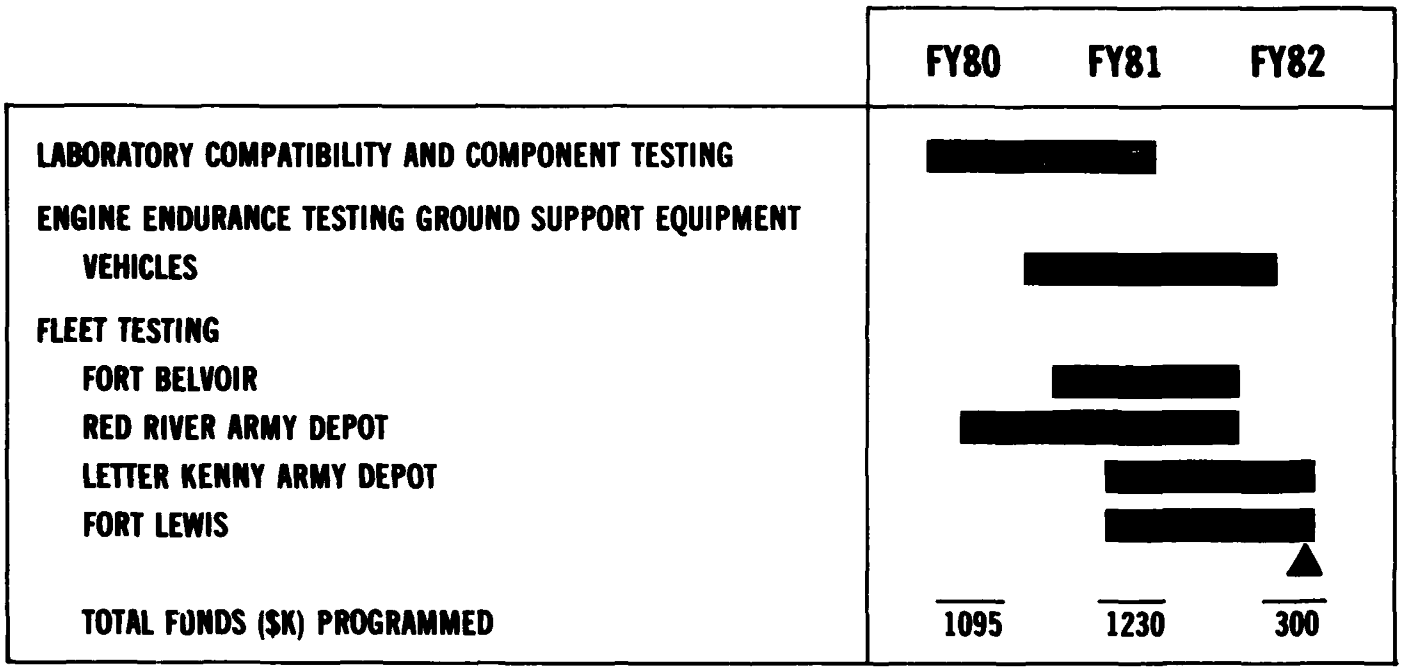
- FRF FORMULATION A (NON-ANTIMIST VERSION) TENTATIVELY SELECTED; MIXTURE IS –
  84% DIESEL
  10% WATER
  6% EMULSIFIER

- FRF FORMULATION A IS –
  - STABLE
  - SELF EXTINGUISHING
  - SMALL DEGRADATION IN PERFORMANCE
  - EASY TO PREPARE (NO HOMOGENIZER RQMT)

FIRE-RESISTANT FUEL (FRF) SYSTEM PROGRAM



GASOHOL PROGRAM



▲ —DEVELOPMENT OF GASOHOL SPECIFICATION FOR TACTICAL EQUIPMENT

HIGH ENERGY FUELS AND ENHANCED FUEL STABILITY

	FY80	FY81	FY82
HIGH ENERGY FUEL			
LABORATORY & ENGINE TESTS OF CANDIDATE EMULSION/ CARBON SLURRY FUELS			
ENGINE ENDURANCE TESTING			
USER ACCEPTANCE TESTS			
TOTAL FUNDS ($K) PROGRAMMED	100	275	300
ENHANCED FUEL STABILITY			
LABORATORY TESTS ON POMCUS & M60A3 FUEL SAMPLES			
FABRICATE FIELD FUEL QUALITY MONITOR			
ISSUE ADDITIVE STABILITY PACKAGE			
TOTAL FUNDS ($K) PROGRAMMED	100	75	340

SUMMARY

- SYNTHETIC/ALTERNATIVE FUELS EFFORT HAS INCREASED EMPHASIS AND PROGRAMMED $'S
- SYNTHETIC FUELS EFFORT WILL CONSIDER ALL TYPES OF NON-CONVENTIONAL CRUDES
- ACCELERATED QUALIFICATION METHODOLOGY WILL SIGNIFICANTLY REDUCE ENGINE/COMPONENT QUALIFICATION INTERVALS
- PROCUREMENT COSTS FOR SYNTHETIC FUELS MAY BECOME MAJOR ISSUE
- GASOHOL PROGRAM IS IN COMPLIANCE WITH RECENT LEGISLATION

SECTION 3. ENGINE DEVELOPMENT - TARADCOM

SECTION 3. ENGINE DEVELOPMENT-TARADCOM

TRADCOM ENGINE FUNCTIONS
INPUT TO DARCOM/DA
FOR ALTERNATE FUEL R&D PLAN

INCL	TABLE OF CONTENTS
1.	Talking Paper; Engine R&D Constraints and Goals
2.	Talking Paper; Multifuel Engines
3.	Talking Paper; Engine R&D Plan for Development of Engines for Alternate Fuels
4.	Charts: Engine R&D Plan fr Development of Engines for Alternate Fuels
5.	Talking Paper; XM-1 Gas Turbine Engine(s) Multifuel Capability
6.	Chart; "Cost and Schedule of" AGT-1500 Multifuel Development
7.	Chart Alcohol Mix Fuel Characteristics
8.	R&D Project Request; Proposed Future Work Requiring Funding Multi-fuel Engine Development Plan
9.	Chart; US Army Ground Vehicle Fuel Use
10.	Chart; Contacts made on future programs
11.	Alternate fuels program for AGT-1500
12.	TRADCOM funding

TALKING PAPER

ENGINE R&D CONSTRAINTS AND GOALS

Cost Constraints

- Buy most cost effective vehicle/engine. (PMO makes engine selection and engine group has no control over selection.)
- Buy commercial vehicle (Example: M880, 1/4 Ton).
- Below 500 hp, buy commercial (MACI) engines. This approach minimizes engine R&D and tooling cost. 86% of Army fuel is consumed by this class of engines.

R&D vs MACI Funds Constraints

- Do not spend R&D dollars to develop low horsepower (<500 hp) engines. Buy commercial engines and use MACI funds to conduct engine tests.
- Do not spend MACI funds to modify commercial engines.

RSI Constraints

- Consider purchase of RSI engines and vehicles (Example: M.A.N. truck).

EPA Constraints

- Meet EPA emissions, smoke, noise standards (Example: in 1978 L-163-S Stratified Charge engine could not meet new EPA standards).

Fuel Constraints/Goal

- Minimize number of fuels in the logistics pipeline (Example: eliminate gasoline, use DF-2 in AGT-1500).
- Use wide cut fuels and future alternate fuels in engines at no or little performance penalty. (Corrosion, combustion, emissions, fuel system effects are unknown).

Performance Constraints/Goal

- Develop/procure high fuel efficient engines with good RAM-D.
- Develop/procure more and better wide fuel tolerant engines.

MULTI-FUEL ENGINES
TALKING PAPER

I. DEFINITION OF A MULTI-FUEL ENGINE

An engine with the ability to operate on a wide range of hydrocarbon fuels (from gasoline to diesel, including shale oil or coal derived fuels, with a wide spread of octane and cetane tolerance) in military vehicles without requiring physical adjustment in the field or compromising engine performance or life.

II. ENGINES WITH INHERENTLY GOOD MULTI-FUEL CAPABILITIES

a. Gas Turbine Engines - Continuous combustion.

b. Stratified Charge Spark Ignition Engines - Less sensitive to octane and cetain ratings.

c. Multi-Fuel Diesel Engines - M.A.N. Combustion System; Divided chamber diesels are less sensitive to cetane rating. (However, VW 22:1 CR divided chamber needs 50 cetane fuel).

d. Adiabatic Diesel - Higher combustion chamber temperature.

III. ENGINES WITH INHERENTLY POOR MULTI-FUEL CAPABILITIES

a. Gasoline Spark Ignition Engine (octane sensitive).

b. Diesel Open Chamber Compression Ignition (cetane sensitive).

IV. TYPICAL MULTI-FUEL ENGINE DEVELOPMENT PROBLEM AREAS

a. Fuel Pump - Fuel pump must be designed to operate over a wide range of fuel densities and temperatures. The fuel pump must be externally lubricated. Diesel fuel pumps typically are designed to use the fuel as a lubrication source.

b. Timing - On compression and spark ignition engines the timing of fuel injection and ignition should be varied with fuel and with engine speed and load conditions to control ignition delay in order to maintain engine peak power and performance.

c. Combustion Chamber and Fuel Injection - The AGT-1500 (gas turbine) and the LDS-465 (compression ignition) engine required special (combustor & air blast fuel nozzle)/combustion chamber designs, respectively, in order to achieve multi-fuel capability.

d. Cold Starting - Diesels require intake manifold burner modifications for cold starting. These burners must be modified to operate over a wide fuel range. Also, some fuels will freeze prior to -65°F, Army specification for engine cold starting capability.

e. Vapor Lock - Vapor lock is a possible problem when running on gasoline.

f. Coking - The AGT-1500 is still experiencing fuel nozzle coking when running at the idel power settings. A wider range in fuel density and viscosity could compound this problem.

V. PRESENT (MULTI-FUEL) OR WIDE-FUEL TOLERANT ENGINES

a. AGT-1500 gas turbine engine in the XM-1 tank.

b. Solar Corporations gas turbine APU for the XM-1 tank.

c. Texaco's stratified charge spark ignition engine. Tested by TARADCOM.

d. LD-465 series of Army diesel engines in 2-1/2 and 5 ton trucks which are now being phased out and replaced by commercial engines.

TALKING PAPER

ENGINE R&D PLAN

DEVELOPMENT OF ENGINES FOR ALTERNATE FUELS

NEAR TERM ACTIONS:

Step-1 FY79 - FY82

Continue testing of wide fuel tolerant engines to determine limits of fuel tolerances for:

- o Gas Turbines (AGT-1500, Gemini)
- o Compression Ignition (LD-465)
- o Spark Ignition (Stratified Charge)
- o Commercial Engines

Step-2 FY79 - FY82

Participate in preparation of new wide fuel specifications which correspond to best projection of DOD/Army wide fuel tolerant engines. (2 or 3 new fuel specifications)

Step-3 FY80 - FY82

Conduct dynamometer engine tests using alternate fuels made to the new specifications and or available fuels to establish limit of fuel specifications for wide fuel tolerant engines.

Step-4 FY81 - FY85

Conduct vehicle tests using alternate fuels and wide fuel tolerant engines including environmental extremes - arctic, low temperature and desert conditions.

R&D ACTIONS:

1. Initiate development of multifuel engine components:

   - o Fuel density and viscosity sensor/compensator
   - o Combustors
   - o Fuel injectors
   - o Fuel controls
   - o Fuel pumps
   - o Cold starting devices

2. Modify some current engines to increase fuel tolerance:

   - o AGT-1500 Gas Turbine (XM-1)
   - o VTA-903 (SP-H) (XM-2)

3. Initiate development of multifuel engines:

   - o Stratified Charged
   - o Adiabatic/Compression Ignition
   - o Gas Turbine

PROCUREMENT ACTIONS:

Establish Required Operational Capabilities (ROC) for all new vehicles, including wide fuel tolerance and high efficiency requirements. This will result in phase out of conventional spark ignition and sompression ignition engines.

POLICY ACTIONS:

Write a R&D and procurement policy requiring:

(1) Wide fuel tolerant engines (set minimum standards)

(2) Fuel efficient engines (set minimum standards)

ENGINE R&D PLAN
DEVELOPMENT OF ENGINES FOR ALTERNATE FUELS

NEAR TERM ACTIONS:

STEP-1 FY79 – FY82

CONTINUE TESTING OF WIDE FUEL TOLERANT ENGINES TO DETERMINE LIMITS OF FUEL TOLERANCE FOR:

- GAS TURBINES (AGT-1500, GEMINI)
- COMPRESSION IGNITION
- SPARK IGNITION (STRATIFIED CHARGE)

STEP-2 FY79 – FY82

DETERMINE NEW WIDE FUEL SPECIFICATIONS

STEP-3 FY80 – FY82

DYNAMOMETER WIDE FUEL TOLERANT ENGINE TEST TO VALIDATE NEW FUEL SPECIFICATIONS

STEP-4 FY81 – FY85

VEHICLE TEST USING ALTERNATE FUELS AND WIDE FUEL TOLERANT ENGINES INCLUDING ENVIRONMENTAL EXTREMES.

R&D ACTIONS:

1. INITIATE DEVELOPMENT OF MULTIFUEL ENGINE COMPONENTS:

   FUEL DENSITY AND VISCOSITY SENSOR/COMPENSATOR
   COMBUSTORS, FUEL INJECTORS, FUEL CONTROLS, FUEL PUMPS, COLD STARTING DEVICES

2. MODIFY SOME CURRENT ENGINES TO INCREASE FUEL TOLERANCE.

3. INITIATE DEVELOPMENT OF MULTIFUEL ENGINES:

   STRATIFIED CHARGED
   ADIABATIC/COMPRESSION IGNITION
   GAS TURBINE

PROCUREMENT ACTIONS:

1. ESTABLISH REQUIRED OPERATIONAL CAPABILITIES (ROC) FOR ALL NEW VEHICLES INCLUDING WIDE FUEL TOLERANCE AND HIGH EFFICIENCY REQUIREMENTS. THIS WILL RESULT IN THE PHASE-OUT OF CONVENTIONAL SPARK IGNITION AND COMPRESSION IGNITION ENGINES.

POLICY ACTION:

WRITE A R&D AND PROCUREMENT POLICY REQUIRING:

(1) WIDE FUEL TOLERANT ENGINES (SET MINIMUM STANDARDS)

(2) FUEL EFFICIENT ENGINES (SET MINIMUM STANDARDS)

TALKING PAPER
XM-1 GAS TURBINE ENGINES
MULTIFUEL CAPABILITY

1. The AGT-1500 turbine engine has a multifuel capability. Since the combustion process of turbine engines in inherently cetane and octane insensitive, successful operation on a wide variety of fuels is readily achieved. The engine fuel control/and fuel system design must have the capability to pump and meter the heavier fuels, and the combustion zone components tailored for efficient, smoke and coke free, operation throughout the engine operating range. Limitations in this fuel omniverability appear to occur only with certain fuels containing traces of base metals, e.g., vanadium.

2. The TARADCOM AGT-1500 Turbine Program took the engine from inception through the fuild and test of 26 engines and feasibility demonstration in four (4) test rig vehicles. In June 1973, the program and assets were transferred to PM-XM1 for further engine development and refinement, for application in a main battle tank candidate vehicle.

3. The basic turbine development program utilized JP5 and DF-1 fuels extensively, with capability demonstration on JP4 and gasoline. The hydromechanical fuel control had fuel density compensation, with an external knob setting for type of fuel in use. A follow-on TRADCOM heavy fuel development program was conducted to further enhance the multifuel capability of the engine. An air blast injector nozzle was introduced along with a change in combustor design, having improved wall cooling and air distribution. DF-2, No. 4 and No. 6 heating oils were concentrated on in the iterative effort with additional demonstration (only) on unleaded gasoline and shale-derived JP5. The gasoline operation brought out the need for a fuel cooler at idle, to preclude recirculation vapor lock. The heavy fuel program combustor design and modification have been incorporated in the latest XM1 AGT-1500 turbine engines.

4. The XM1 engine development continues to emphasize DF-2 fuel use. Arctic diesel fuel (DF-A) is essentially the same as JP4, which should be equally compatible with the combustor system. The fuel control on the tank has been changed from hydromechanical to electronic in the XM1 system, biasing fuel flow based on turbine temperature and other operating parameters, thereby eliminating the need for separate fuel density compensation. Jet A and JP8 fuels fall between JP5 and JP4, and can be substituted with equal success. Marine diesel (MIL-F-16884) fuel operation has been successful, although the heavier marine distillate fuel (similar to No. 4 heating oil) encountered some problems with light-offs and recuperator deposit formation.

5. XM1-M60 APU: The turbine XM1-M60 APU now being developed for TRADCOM by Solar, like the AGT-1500, has multifuel capability. The "Gemini" engine has been qualified on JP-4 and DF-2 fuels operating 1000 hours on each. It has also been operated 20 hours each on JP-5, DF-1 Arctic diesel and gasoline. The engine will operate on the above mentioned fuels without need for engine adjustments.

6. There is a MERADCOM test program began in August 1979 where two engines will each operate 200 hours on contaminated fuel, fuel with 25 milligrams of dirt in each liter of fuel.

AGT-1500 MULTIFUEL DEVELOPMENT PROGRAM

TARADCOM INITIAL DEVELOPMENT

- TIME FRAME/FUNDING — 1974 – 1975/$206K
- ACCOMPLISHMENTS
  - PROTOTYPE AIR BLAST FUEL INJECTORS
  - MODULAR EXPERIMENTAL COMBUSTOR
  - BENCH RIG TESTING

TARADCOM ADVANCED DEVELOPMENT

- TIME FRAME/FUNDING — 1976 – 1978/$258K
- ACCOMPLISHMENTS
  - OPTIMIZED AIR BLAST FUEL INJECTOR W/PILOT INJECTION FOR IGNITION
  - FINAL COMBUSTOR DESIGN W/IMPROVED SWIRLER
  - ENGINE TESTING

PMO – XM1 FULL SCALE ENGINEERING DEVELOPMENT (DF-2)

- TIME FRAME/FUNDING — 1976 – 1979/$1,000K
- ACCOMPLISHMENTS
  - AIR BLAST FUEL INJECTOR SPRAY PATTERN IMPROVEMENT
  - PRE-PRODUCTION COMBUSTOR W/IMPROVED AIR MIXING
  - FIELD TESTING

ALCOHOL MIX FUEL CHARACTERISTICS

- RAISES OCTANE RATING 2 TO 3 POINTS (GASOHOL)
- LOWERS CETANE RATING UP TO 7 POINTS (IN #2 DIESEL)
- ETHANOL/METHANOL BASE LIQUIDS MUST BE KEPT DRY
- ATTACKS SOME SENSITIVE GASKET/HOSE MATERIALS
- DISSOLVES FUEL SYSTEM DEPOSITS
- NOMINAL 5% LESS BTU CONTENT (GASOHOL)

FUELS SUMMARY

	OCTANE (R+M)/2	PRICES $/GAL	SOURCE
LEADED REGULAR GASOLINE	89.7	.725	PETROLEUM
LEADED PREMIUM GASOLINE	95.2	.789	PETROLEUM
UNLEADED REGULAR GASOLINE	88.2	.774	PETROLEUM
UNLEADED PREMIUM GASOLINE		.874**	PETROLEUM
GASOHOL*	90.2	.849**	PETROLEUM/ETHANOL
ETHANOL		1.02	MILO
		1.05	CORN
		1.31	WHEAT
METHANOL		.32–.45	BITUMINOUS COAL
		.38–.50	LIGNITE COAL
		.85	SOLID WASTES

*90% UNLEADED GASOLINE/10% ETHANOL

**IOWA/VIRGINIA SAMPLE

MULTIFUEL ENGINE DEVELOPMENT PLAN

PROPOSED FUTURE WORK REQUIRING FUNDING

1. Small Bore Multifuel Engine Development: A small bore family of engines to cover power requirements from 60 to 200 for vehicles such as the M151 1/4 Ton Truck (Jeep), M880 1-1/4 Ton Truck and for general application in light duty trucks. This family of engines to have fuel economy requirements of good diesel engines and specified emission standards.

a. Stratified Charge L-163-S: Continued development of the Stratified Charge L-163-S engine (65 hp 2 3500 rpm). Hardware availability at end of FY79 will be three jeep vehicles with L-163-S engine installation and two engines. A two year program is proposed to continue development for multifuel operation and continue field operation for determination of fuel economy and emissions.

1st Year	250K
2nd Year	250K

b. Design Study of a Multifuel Engine Family Based on the L-163-S Engine: A one year program is proposed to provide a design plan for an engine family based on the L-163-S engine in 4, 6 and 8 cylinder configurations.

1st Year	150K

2. Engineering Development Program - Intermediate Multifuel Engine Family: An intermediate family of engines to cover power requirements to 1000 hp for multifuel combustion, high efficiency and potential for family members of good emissions and performance. A design study is proposed of best possible adaptation of the VHO developments and features for a new program for the future.

1st Year	500K
2nd Year	500K
3rd Year	1000K

3. Rotary Stratified Charge Engine Program: Investigation of potential of the Navy Rotary Engine Program as the basis for a multifuel engine program in one rotor (350 hp) and 2 rotor sizes (750 hp). This system to be based on the Curtiss Wright Stratified Charge System. This could be a candidate for a cooperative Army/Navy program.

a. Cooperative Army/Navy Multifuel Capability Investigation:

1st Year	250K
2nd Year	250K

b. Installation - 350 Hp Rotary Engine: Installation of the 350 hp engine in a truck.

1st Year	500K
2nd Year	500K

c. Installation - 750 Hp Rotary Engine: Installation of the 750 hp engine in a combat vehicle.

1st Year	500K
2nd Year	1000K
3rd Year	250K

4. Air-Cooled Multifuel Engine Family for Trucks: Development of a multifuel family to replace the 427/465 multifuel engine family. This family of engines is too large and heavy and consideration should be given to an air cooled multifuel engine family for the 2-1/2 Ton, 5 Ton Truck category. This study to encompass potential use of Deutz Air Cooled Diesel family Member specially developed for a military capability with development of the combustion system necessary for wide fuel tolerance. These engines we currently sold with a combustion chamber similar to the M.A.N. or with a two stage combustion chamber. This program should establish an optimized combustion system for the high output military diesel in the truck sizes.

1st Year	1000K
2nd Year	1000K
3rd Year	500K

5. Multifuel Development of AVDS 1790 Diesel Engine: Development of a multifuel combustion system and kit which could be used to convert the AVDS 1790 tank engines in the field to multifuel use. Work on this project has already started. Additional development is necessary to provide a better intake manifold temperature distribution between cylinder, to minimize performance differences when operating on different fuels, increase fuel tolerance and to provide hardware suitable as a kit to use on the M60 Tank.

1st Year	500K
2nd Year	500K
3rd Year	250K

6. Multifuel Combustion System Development for the 1360 VCR Engine (1500 Hp):

1st Year (FY80)	250K
2nd Year (FY81)	500K
3rd Year (FY82)	1000K

7. Multifuel Combustion Research Program: A combustion research and development program is needed to study basic multifuel combustion systems to explore parameters of combustion necessary to develop simple, efficient clean burning system for the future. This program will be conducted primarily at Universities in single cylinder test work to explore potential of multifuel operation and design parameters of combustion systems for optimization for multifuel operation.

1st Year	500K
2nd Year	500K
3rd Year	500K

8. <u>Multifuel Program for the Adiabatic Diesel Engine</u>: A specialized research program is needed to develop a multifuel combustion system for the Adiabatic Diesel Engine program. Exploration of multifuel operation in the very high temperature relatively uncooled regime is needed. The Army Adiabatic engine development is currently going on at Cummins on the VT903 Engine.

1st Year	250K
2nd Year	500K
3rd Year	1000K

9. <u>AGT-1500 Turbine Multifuel Development</u>: Continued research and development aimed at expanding current multifuel capability of the present AGT-1500 turbine with application to general turbine combustion systems. The approach to this program will be to conduct research in basic turbine combustion at Purdue and to pursue specific developments of the combustion system at Lycoming. This program will provide advancement of the turbine multifuel operational capability for the future.

1st Year	500K
2nd Year	500K
3rd Year	500K

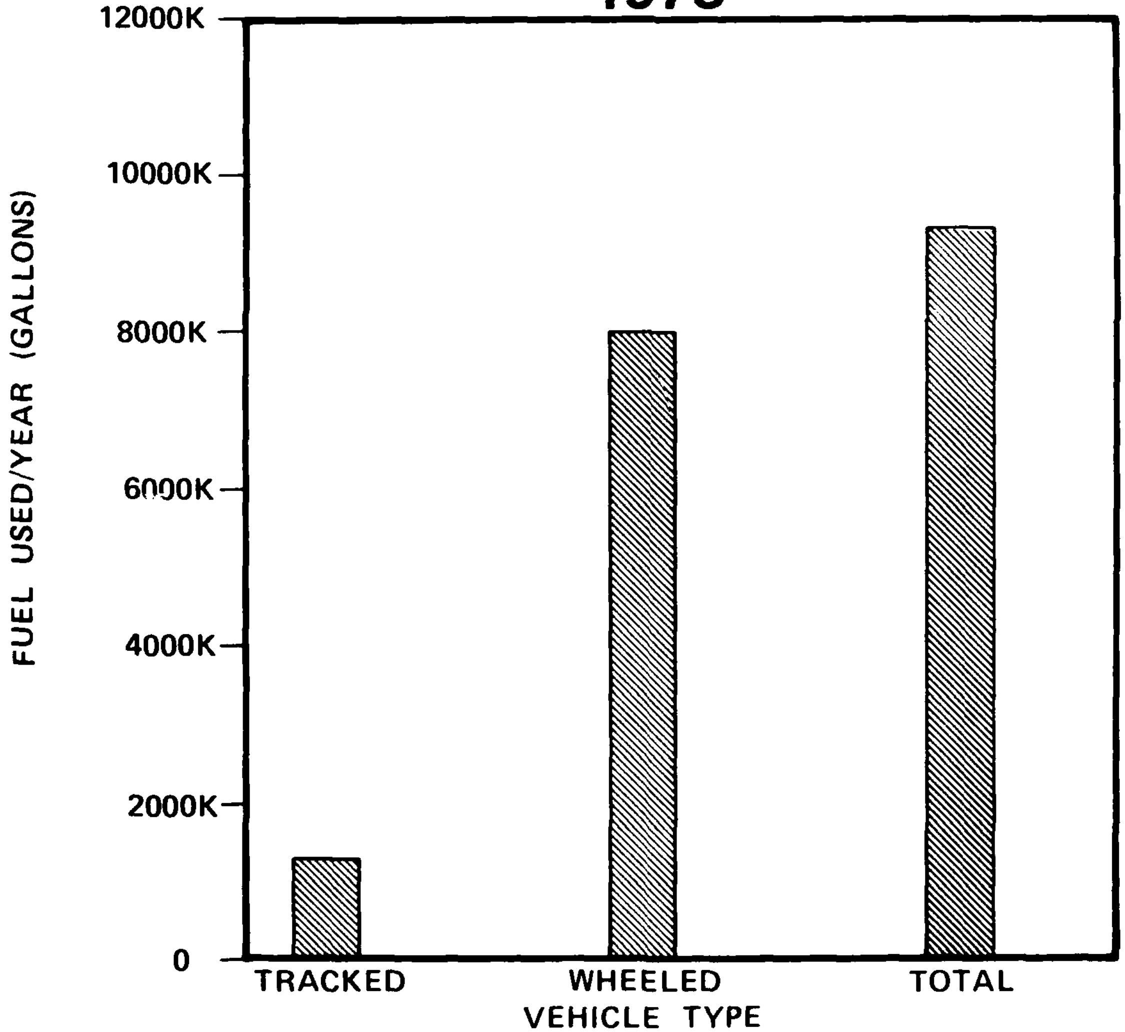
MULTIFUEL ENGINE RESEARCH & DEVELOPMENT PLAN

PROPOSED FUTURE WORK

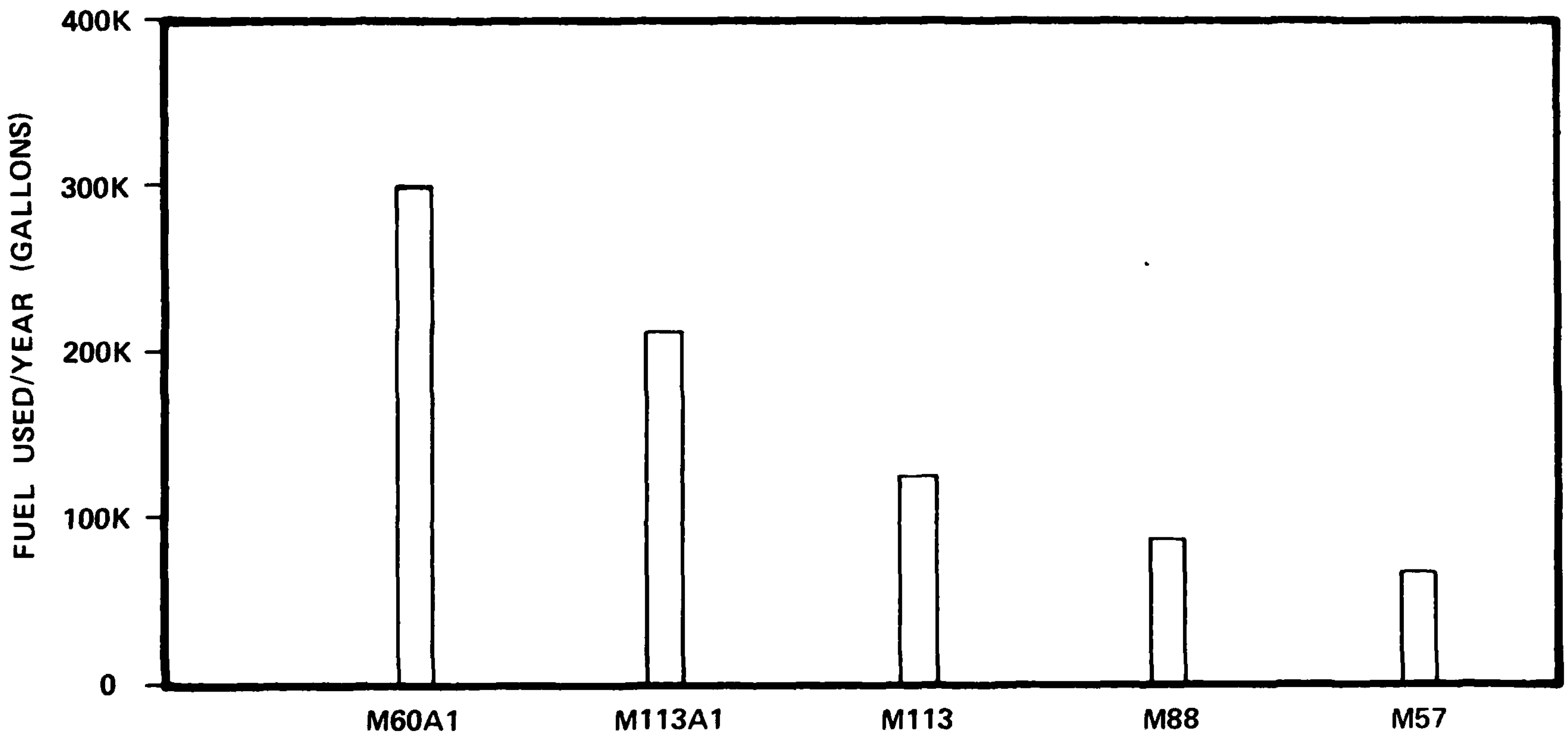
PROJECT	1ST YEAR	2ND YEAR	3RD YEAR	PRIORITY
1. Small Bore Multifuel Engine Development				5
a. Stratified Charge L-163-S (Continued Development)	250K	250K		
b. Design Study – Small Bore Multifuel Engine Family	150K			
2. Engineering Development Program – Intermediate Multifuel Engine Family to 1000 Hp	500K	500K	1,000K	6
3. Rotary Stratified Charge Engine Development				9
a. Cooperative Army/Navy Multifuel Capability Investigation	250K	250K		
b. Installation – 350 Hp Engine in a Truck	500K	500K		
c. Installation – 750 Hp Engine in a Tank	500K	1,000K	250K	
4. Air Cooled Multifuel Engine Family for Trucks	1,000K	1,000K	500K	8
5. Continue Multifuel Development of AVDS 1790 Diesel Engine	500K	500K	250K	4

PROJECT	1ST YEAR	2ND YEAR	3RD YEAR	PRIORITY
6. Multifuel Combustion System Development for the 1360 VCR Engine (1500 Hp)	250K	500K	1,000K	7
7. Multifuel Combustion Research Program (University Research)	500K	500K	500K	2
8. Multifuel Program for the Adiabatic Diesel Engine (Based on VT903 Engine) (High Output, High Temperature Uncooled Engine)	250K	500K	1,000K	3
9. Continue AGT-1500 Turbine Multifuel Development	500K (80K funded FY79)	500K	500K	1
TOTALS	5,150K	6,000K	5,000K	

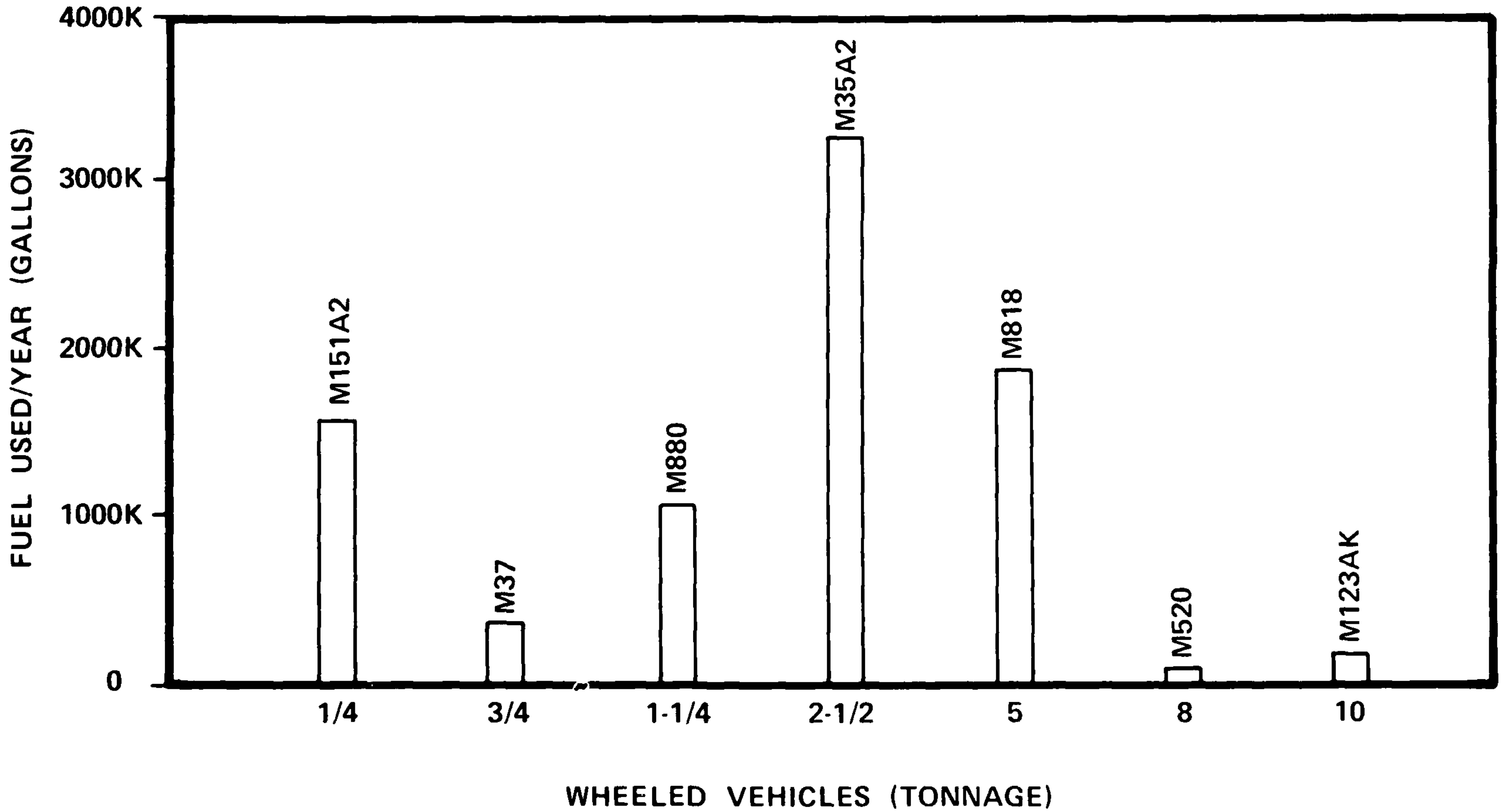
TOTAL ARMY FUEL CONSUMED
1978



TRACKED
TOTAL ARMY FUEL CONSUMED
1978



WHEELED TOTAL ARMY FUEL CONSUMED 1978



CONTACTS MADE ON FUTURE PROGRAMS

1. Cummins

   a. Adiabatic diesel - multifuel work

   b. Spark ignited diesel study

2. Lycoming

   a. AGC-1500 alternate fuel R&D

   b. Purdue/Lycoming combustion model

3. Teledyne

   a. Continue ABDS 1790 multifuel R&D

4. Wayne State University

   a. Single cylinder injection/combustion R&D

5. Purdue University

   a. Combustion modeling

6. Air Research

   a. GT 601 alternate fuel R&D

7. Williams Research

8. Hyperbar/Cummins/NASA/Harp

   a. Turbo-machinery

9. Physics Int/Cummins

   a. Feed back fuel control/injector

Alternate Fuels Program for AGT-1500 Engine

1. AGT-1500 combustor developed in part under TRADCOM funding is already reasonable fuel tolerant. Significant background experience has been reported on fuels ranging from gaosline to No. 4 fuel, with some testing on No. 6 residual fuel.

2. The characteristic time modelling concept (Mellor, Purdue) has been developed in large part with TARADCOM and ARO funding, and initial applications have been made to the AGT-1500 combustor. Capability to apply this modelling concept exists at AVCO.

The basic program approach to the use of alternate fuels sould be:

1. Analyze probable problem areas using existing data supplemented by limited bench and laboratory tests.
2. Arrange to procure a modern AGT-1500 engine.
3. Expand the data base with appropriate combustor laboratory and engine tests. Identify all problem areas.
4. Take remedial action to eliminate problems, and test modified designs to prove adequacy, using appropriate laboratory and engine tests.
5. Qualify the engine on the fuels of interest.

AVCO Assets available for AGT-1500 fuels evaluation

1. Fuels lab for nozzle performance evaluation
   pressure drop versus fuel flow
   spray angle
   patternation of spray
   Drop size distribution at atmospheric pressure
   (last 2 items needed at moderate pressure, but new rig is needed)

2. Atmospheric tests in combustor laboratory
   Simple Pipe Rig tests for ignition and efficiency at atmospheric pressure
   (A test rig for better simulation of approach flow would help - not vital)

3. Full pressure rig to test liner and scroll together (from F.E. program)
   Permits operation along an engine operating line, with variations to account for ambient conditions, engine degradation, etc.
   (needs capability to operate at cold ambients - air and fuel)

4. Engine (-07 updated to -08, Prod Design)
   For system compatibility
   Extended endurance - effects on hot end components, from metallic components in fuel, coking effects.
   One or more engines should be obtained from PMO when they become surplus in 1980

5. Analytical tools
   Mellor characteristic time model
   AVCO Vaporization program

Effect of fuel types on AGT-1500 Operation

1. Ignition

2. Effect on false or aborted starts (fuel drainage)

3. Efficiency during starting cycle
   a) white smoke during starts
   b) fuel control schedule compatibility with fuel during starting cycle.

4. Idel fuel consumption - Combustor efficiency

5. Coke deposition on fuel nozzle - low power

6. Black smoke at low power
   adversely affected by low fuel hydrogen or high aromatic content

7. Liner coke deposition - turbine wear

8. Liner/Scroll wall temperature
   affected by flame luminosity, which increases with decreasing hydrogen content

9. Turbine Inlet Temperature Distribution

10. Fuel Thermal Stability - Impact on coking inside fuel nozzle and flow divider valve

11. Metallic components in fuel, S, Va, etc.
    Effect on hot end life.

12. Effect of fuel chemistry on seals and other materials.

Items 1, 4, 8, 9, 12 are best evaluated by appropriate laboratory and/or bench tests

Items 2, 5, 6, 7 can be evaluated in new AGT-1500 high pressure combustor rig

Items 2, 3, 5, 6, 7, 10, 11 are best evaluated in engines

Priority	Title	FY80	FY81	FY82	FY83	FY84	FY85	FY86
1.	AGT-1500							
	a. Fuel Economy	1,860*	(750)	–	–	–	–	–
	b. PIP	–	–	1,650	3,150	2,600	2,500	–
2.	Adiabatic Engines	566	0	6,531	6,000	4,500	4,000	1,048
3.	Air Cleaners	339	554	720	630	850	850	850
4.	Advanced Diesel	750	2,500	← FUNDED BY ARRADCOM →				
5.	Engine Concepts for Alternate Fuels	–	0	2,000	3,500	3,500	3,600	6,247
6.	Advanced Turbine Engine Demonstrator	–	700	2,600	3,500	5,746	5,993	7,293
7.	Advanced Turbine Component Development	–	220	2,249	1,744	1,300	1,400	2,000
8.	Advanced MBT Diesel	–	–	–	1,500	1,800	2,300	3,500
	Totals	3,515	3,974	15,750	20,024	20,296	20,643	20,938

* $339K in funds transferred to CVX-650 Program

AH91

TASK	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86
Advanced Adiabatic Technology	511	425	600	550	1,400	1,400	2,400	3,076
Adv Turbine Technology	150	314	0	521	1,000	1,425	750	590
Eng Concepts for Alternate Fuels	0	0	900	1,000	1,500	1,777	1,777	2,000
Adv Filtration Technology	0	0	800	1,000	600	400	400	400

SECTION 4. ENGINE DEVELOPMENT - AVRADCOM

TARADCOM PROGRAM GUIDANCE

TITLE: ENGINE CONCEPTS FOR ALTERNATE FUELS

		FY-81	FY-82	FY-83	FY-84	FY-85	FY-86
6.2	AH 91	900K	1,000K	1,500K	1,777K	1,777K	2,000K
6.3	DG-07	0	3,000K	3,500K	3,500K	3,600K	6,000K
	TOTALS	900K	4,000K	5,000K	5,277K	5,377K	8,000K

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ARMY MOBILITY ENERGY RESEARCH & DEVELOPMENT PLAN.(U)
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PRIORITY PROJECTS FOR FY81 ENGINE CONCEPTS FOR ALTERNATE FUELS

		Funding Amount	Program Element
1.	AGT 1500 Turbine Multifuel Continued Development	0	6.3 DG 07
2.	Multifuel Combustion Systems Research (University/Industry)	550K	6.2 AH 91
3.	Adiabatic Diesel Multifuel Research	250K	6.2 AH 91
4.	AVDS 1790 Multifuel Combustion System	0	6.3 DG 07
5.	Small Bore Multifuel Engine Research		
	a. Spark Ignited Diesel Study	100K	6.2 AH 91
	b. Small Bore Engine Family Dev.	0	
	TOTAL	900K	
	SUB-TOTALS		
	Items 2, 3 and 5a above	900K	6.2 AH 91
	Items 1, 4 and 5b above	0	6.3 DG 07

PRIORITY PROJECTS FOR FY82
ENGINE CONCEPTS FOR ALTERNATE FUELS

		Funding Amount	Program Element
1.	AGT 1500 Turbine Multifuel Continued Development	500K	6.3 DG 07
2.	Multifuel Combustion Systems Research (University/Industry)	500K	6.2 AH 91
3.	Adiabatic Diesel Multifuel Research	500K	6.2 AH 91
4.	AVDS 1790 Multifuel Combustion System	500K	6.3 DG 07
5.	Small Bore Multifuel Engine Family	400K	6.3 DG 07
6.	Intermediate Multifuel Engine Family (Up to 1000 HP)	500K	6.3 DG 07
7.	1360 VCR Engine (1500 HP) Multifuel Dev.	500K	6.3 DG 07
8.	Air Cooled Multifuel Engine Family for Trucks	600K	6.3 DG 07
	TOTAL	4000K	
	SUB-TOTALS		
	Items 2 and 3 above	1000K	6.2 AH 91
	Items 1, 4, 5, 6, 7 and 8 above	3000K	6.3 DG 07

PRIORITY PROJECTS FOR FY83
ENGINE CONCEPTS FOR ALTERNATE FUELS

		Funding Amount	Program Element
1.	AGT 1500 Turbine Multifuel Continued Development	500K	6.3 DG 07
2.	Multifuel Combustion Systems Research (University/Industry)	500K	6.2 AH 91
3.	Adiabatic Diesel Multifuel Research	1000K	6.2 AH 91
4.	AVDS 1790 Multifuel Combustion System	250K	6.3 DG 07
5.	Small Bore Multifuel Engine Family	500K	6.3 DG 07
6.	Intermediate Multifuel Engine Family (Up to 1000 HP)	1000K	6.3 DG 07
7.	1360 VCR Engine (1500 HP) Multifuel Dev.	500K	6.3 DG 07
8.	Air Cooled Multifuel Engine Family for Trucks	750K	6.3 DG 07
	TOTAL	5000K	
	SUB-TOTAL		
	Items 2 and 3 above	1500K	6.3 AH 91
	Items 1, 4, 5, 6, 7 and 8 above	3500K	6.3 DG 07

23 Nov 79

EXPLANATION OF PROGRAMING PLAN
FOR ENGINE CONCEPTS FOR ALTERNATE FUELS
FY81, FY82, and FY83

1. Actual program guidance for FY81 and FY82 are less than funding proposed in the Multifuel Engine Research and Development Plan Proposed Future Work as follows:

	Proposed	Guidance	Shortfall
FY81	5150K	2050K	3100K
FY82	6000K	4000K	2000K
FY83	5000K	5000K	0 K
		Total Shortfall	5100K

2. In establishing the programs for FY81, FY82 and FY83, the lowest priority program was eliminated and the next two lowest priority projects were undertaken at a lower funding level than originally proposed in order to balance proposed work vs guidance.

a. Originally 3250K was proposed for work on Rotary Stratified Charge Engine Development.

b. The 1360 VCR (1500 HP) Multifuel Engine Development was reduced from 1750K in 3 years to 1000K.

c. The Air Cooled Multifuel Family for Trucks was reduced from 2500K in 3 years to 1150K.

d. An extra 50K was added to the Multifuel Combustion System Research Program in FY81. The 50K was insufficient to undertake another priority item and it was placed into the research program.

ARMY TURBINE ENGINES

MULTI-FUELS

RESEARCH

DEVELOPMENT

TEST

QUALIFICATION

DEFINITION

AVIATION

MULTI-SOURCE-FUEL ENGINES – ENGINES WHICH HAVE THE CAPABILITY TO BURN FUELS FROM A VARIETY OF SOURCES eg PETROLEUM, COAL, TAR SAND AND OIL SHALE EACH MEETING CURRENT MILITARY/AVIATION JET FUELS SPECIFICATION, WITHOUT A CHANGE IN POWER CAPABILITY

PERMISSIBLE COMPROMISES:

- ADJUSTMENTS MAY BE DEFINED AND PERMITTED eg BELOW -20° F
- NO OPERATIONAL REQUIREMENTS BELOW 12 cS OR CURRENT MODEL SPEC
- UP TO 15% REDUCTION IN COMPONENT LIFE PERMISSIBLE eg COMBUSTOR
- KITS PERMITTED BELOW -20F

TYPICAL-TURBINE ENGINE QUALIFICATION TESTS/HOURS

OFFICIAL TESTS	TEST HOURS
PRELIMINARY FLIGHT RATING TESTS (PFRT)	165
• ENDURANCE TEST	100
• ALTITUDE TEST	35
• ENGINE OVERTEMPERATURE	10
• ATTITUDE TEST	10
• INFRARED RADIATION (ANALYSIS)	–
• CUSTOMER BLEED AIR	10
MODEL QUALIFICATION TESTS (MQT)	2,085 (2,235)
• ENDURANCE TEST	500
• ALTITUDE TEST	240
• LOW AND HIGH TEMP. STARTING AND ACCELERATION	10
• ATMOSPHERIC WATER INGESTION	25
• CORROSION SUSCEPTIBILITY TEST	25 (150)
• SAND INGESTION TEST	100
• EXHAUST SMOKE EMISSION (EXHAUST WAKE) TEST	5
• LOW CYCLE FATIGUE ENGINE TEST	300
• ENGINE OVERTEMPERATURE	10
• INFRARED RADIATION TEST	10
• CUSTOMER BLEED AIR TEST	10
ACCELERATED MISSION TEST (AMT)	300
TOTAL HOURS	2,700

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TYPICAL TURBINE ENGINE UNOFFICIAL TEST HOURS

TEST	ESTIMATED TEST HRS
• ALTITUDE EXPLORATORY	100
• PRELIMINARY SAND INGESTION	50
• PRELIMINARY SMOKE EMISSION	5
• EXHAUST GAS POLLUTANTS MEASUREMENT	5
• ENGINE PERFORMANCE	50
• HIGH PRESSURE TURBINE STRESS AND TEMPERATURE	20
• LOW PRESSURE TURBINE STRESS AND TEMPERATURE	20
• LOW CYCLE THERMAL FATIGUE ASSURANCE	150
• PFRT ASSURANCE	80
• MQT ASSURANCE	350
TOTAL	830

OFFICIAL TURBINE ENGINE COMPONENT QUALIFICATION TESTS

COMPONENT	PFRT ACC AGING	PFRT RM TEMP	PFRT HOT TEMP	PFRT COLD TEMP	PFRT ENVIRO	PFRT EMI	MQT ACC AGING	MQT RM TEMP	MQT HOT TEMP	MQT COLD TEMP	MQT ENVIRO	MQT FUEL SYS PERF	MQT FUEL HEATER	MQT PUMP CAVITATION	MQT EMI
• HYDROMECHANICAL UNIT	X	X	X	X	X	X	X	X	X	X	X	X		X	X
• FUEL FILTER	X	X	X	X	X		X	X	X	X	X	X		X	
• ALTERNATOR/GENERATOR	X	X		X	X	X	X	X	X	X	X				X
• ELECTRICAL CONTROL UNIT	X	X		X	X	X	X	X	X	X	X				X
• IGNITION EXCITER	X	X	X	X	X	X	X	X	X	X	X				X
• WIRING HARNESS	X	X		X	X	X	X	X	X	X	X				X
• ANTI-ICING/START BLEED VALVE	X	X		X	X	X	X	X	X	X	X				X
• OIL COOLER			X	X					X	X		X	X		
• IGNITION LEADS	X	X	X	X	X	X	X	X	X	X	X				X
• PUMP, FUEL BOOST	X	X	X	X			X	X	X	X		X		X	
• SEQUENCE/FLOW DIVIDER	X	X	X	X	X		X	X	X	X	X	X			
• IGNITOR PLUGS	X	X	X	X	X		X	X	X	X	X				X
• IGNITION LEADS	X	X	X	X	X		X	X	X	X	X				X
• FUEL, MANIFOLD, INJECTORS		X	X	X				X	X	X		X			
• PRIMER NOZZLES															

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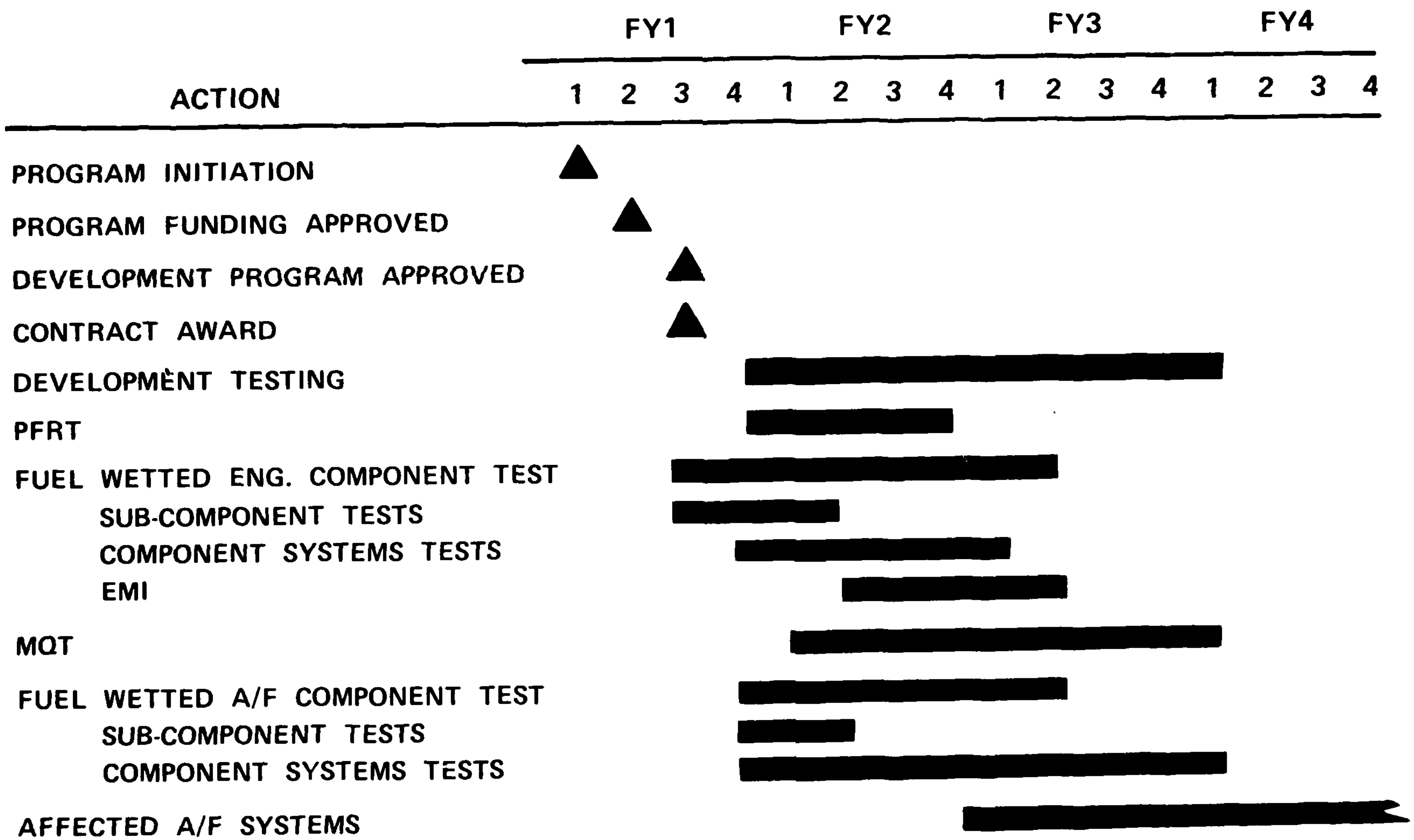
COMPONENT QUALIFICATION EXPECTED TEST HOURS

TEST NOMENCLATURE	NO. TEST ARTICLES	NO. HOURS	TOTAL HOURS
• ACCELERATED AGING	13	168	2,184
• HOT TEMPERATURE	14	100–300	1,400
• ROOM TEMPERATURE	14	12–300	4,200
• COLD TEMPERATURE	14	12–20	280
• PUMP CAVITATION	2	2	4
• ENVIRONMENTAL HUMIDITY FUNGUS SAND & DUST VIBRATION CARBON FOULING WATER FOULING	14	APPROX 100	1,400
			APPROX 9,468

PROGRAM SCHEDULE



ARMY ENGINE PROGRAM SCHEDULE

RDT&E CONTRACT

ENGINE MODEL	AIRCRAFT TYPE	GAL REQ	FY 80 COST 3.6	81 8.0	82 6.6	83 5.4	84 3.0	85 0.4	86	87	88	COST 27.0
● T700-GE-700	UH-60	135K	1.3	1.7		RETROFIT						3.0
-401	SH-60											
● T53-L-703	AH-1	336		1.7	1.8	2.0						5.5
-13B	UH-1											
-15/701A	OV-1											
● T55-L-712	CH-47	560	1.2	2.2	2.6							7.0
-11	CH-47											
-7	CH-47											
● T63-A-720	OH-58	72		0.5	1.7	1.2	0.6					3.0
	OH-6											
-700	OH-58											
● T-62T-40	UH-60	27	0.6	1.1	0.3							2.0
-16	CH-54											
-2B	CH-47											
-2A1	CH-47											
● GTP36-55	AH-64	27	0.5	0.8	0.2							1.5
● T74-CP-700	U-21	179				1.0	1.0					2.0
-WV-702	U-21											
● PTGA-27/28	U-21											
-38/41	C-12											
● T73-P-1/700	CH-54	723/TOTAL 2063K				1.2	1.4	0.4				3.0

ALTERNATE APPROACHES

ENGINE	A/C	ALTERNATIVE #1	ALTERNATIVE #2
• T700-GE-700	UH-60	POSSIBLE JOINT ARMY/NAVY	NONE
-401	SH-60	PROGRAM	
• T53-L-703	AH-1		REPLACE T53 ENGINES WITH T700 ENGINES,
-13B	UH-1	CONVERT -13B to -703	DECREASE IN FUEL CONSUMPTION
-15/701	OV-1	CONVERT -15 TO -701	
• T55-L-712	CH-47		REPLACE WITH NEW DEV ENGINE
-11	CH-47	CONVERT -11 TO -712	TO YIELD 30% FUEL REDUCTION,
-7	CH-47	REPLACE -7 WITH -712	45% INCREASE IN RANGE
• T63-A-720	OH-58		REPLACE WITH NEW DEVELOPMENT
-700	OH-58	REPLACE -700 WITH -720	ENGINE TO YIELD 30% FUEL REDUCTION
-5A	OH-58	REPLACE -5A WITH -720	
• T-62T-40	UH-60	POSSIBLE JOINT ARMY/NAVY	REPLACE WITH NEW APU TO YIELD
-16	CH-54	PROGRAM FOR DEVELOPMENT	DECREASED FUEL CONSUMPTION AND
-2B	CH-47	AND RETROFIT	UNIT WEIGHT
-2A	CH-47		
• GTCP36-55	AH-64	POSSIBLE JOINT ARMY/AIR FORCE PROGRAM	NONE
• T74-CP-700	U-21	POSSIBLE JOINT SERVICES	REPLACE WITH DEVELOPED VERSION
• WV-702	U-21	PROGRAM TO INCLUDE T400 FOR	OF ATDE 800 SHP WITH 25% DECREASE
• PT6A-27/28	U-21	DEVELOPMENT AND RETROFIT	IN FUEL CONSUMPTION
• PT6A-38/41	C-12		
• T73-P-1/700	CH-54	POSSIBLE JOINT SERVICE PROGRAM	SCRAP AIRCRAFT

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SUMMARY

- FOR MODEST R&D FUNDS, ARMY AIRCRAFT ENGINES CAN BE READY FOR RETROFIT FOR MULTI-FUEL USAGE IN FY 85 TIME FRAME

ASSUMPTIONS:

→ FY 80 GO-AHEAD

→ DEFINED COMPROMISES ACCEPTABLE TO USER

→ FUELS MEET JP-8 SPEC

- RESOURCES REQUIRED NOT CURRENTLY AVAILABLE IN AVIATION R&D PROGRAM

SECTION 5. ENGINE DEVELOPMENT - MERADCOM

MERADCOM

- FUELS RESEARCH AND SPECIFICATION DEV
- FUEL HANDLING EQUIPMENT RESEARCH
- GROUND SUPPORT EQUIPMENT RESEARCH

- MULTISOURCE FUEL ENGINE QUALIFICATION
- ALTERNATE FUEL ENGINE COMBUSTION RESEARCH
- MULTIFUEL ENGINE DEVELOPMENT

MERADCOM ENGINE THRUSTS

- MULTISOURCE FUEL – ENGINE EVALUATION
  - GEN SET ENGINES – SPARK IGNITION
    - COMPRESSION IGNITION
    - GAS TURBINE
- ALTERNATIVE FUEL COMBUSTION RESEARCH
  - GEN SET INTERNAL COMBUSTION ENGINE
  - GEN SET EXTERNAL COMBUSTION ENGINE
- MULTIFUEL ENGINE DEVELOPMENT

MERADCOM

MULTISOURCE FUEL-ENGINE QUALIFICATION

- **PERFORMANCE SCREENING**

POWER SIZE	S.I.	C.I.	G.T.
3-10 KW	MS 6 HP	ONAN DJ99E	SOLAR GEMINI
	MS 20 HP		WILLIAMS WR-34
15-30 KW		HERC 198/298	AIRESEARCH GTP36-51
60-100 KW		AC 3500	SOLAR T-62
		CAT 333	
100-200 KW		CAT 343	DDA-404

- **DURABILITY TESTING**

CANDIDATE MULTISOURCE FUELS FOR ENGINE EVALUATION

<table>
<tr><td colspan="3">TAR SAND DERIVED</td></tr>
<tr><td colspan="3">COAL DERIVED</td></tr>
<tr><td colspan="3">OIL SHALE DERIVED</td></tr>
<tr><td colspan="3">CRUDE OIL DERIVED</td></tr>
<tr><td>GASOLINE
MOGAS LEADED
MOGAS UNLEADED
AV GAS</td><td>JET FUEL
JP4, 5, 8
JET A A1
KEROSENE</td><td>DIESEL
DF1, 2, A
MARINE</td></tr>
</table>

52+ VARIATIONS

ALTERNATIVE FUELS

- METHANOL, ETHANOL
- OIL SHALE, COAL, TAR SAND

  (NOT REFINED TO PRES. SPECS—
  Lo IN H_2, HI IN N_2 ETC)
- GAS (PROPANE, METHANE, LNG)
- BLENDS

CANDIDATE POWER PLANTS
ALTERNATIVE FUEL COMBUSTION RESEARCH

PERFORMANCE SCREENING

- ICE – SPARK IGNITION
  - COMPRESSION IGNITION
  - GAS TURBINE
- ECE – RANKINE
  - STIRLING
  - BRAYTON
  - FUEL CELL
- COMBINED CYCLES

ALTERNATIVE FUELS COMBUSTION RESEARCH

PERFORMANCE SCREENING EMPHASES

- UTILIZE COMBUSTION TEST RIGS,
- SMALL POWER PLANTS
- REPRESENTATIVE POWER PLANT

RESULT:

MINIMUM CONSUMPTION – CANDIDATE FUELS

MINIMUM COSTS:

TESTING

INVESTMENT

MODIFICATION

MERADCOM MULTIFUEL ENGINE DEVELOPMENT

- BASED ON ALTERNATIVE FUEL COMBUSTION RESEARCH
- CONCENTRATE ON SMALL ENGINE SIZES
- ALTERNATIVE FUEL DEFINITION CRITICAL
- ENGINE-COMBUSTION SYSTEM SELECTED FOR SCALE UP CAPABILITY

10 KW SIZE TURBINE
AS
TEST BED ENGINE

BENEFITS COMPARED TO PROPULSION OR UTILITY TYPE GAS TURBINES:

- MINIMUM CONSUMPTION OF FUEL/AIR RESOURCES
- FLEXIBILITY
  - MINIMUM IMPACT ON TEST FACILITY FOR ALTERNATE COMPONENT CONFIGURATIONS
  - VARIETY OF COMBINATIONS OF CERAMIC/METAL COMPONENTS WITH SEVERAL ENGINES AT LESS COST
- ECONOMIC EXPOSURE OF VARIETY OF HOT FLOW PATH CERAMIC COMPONENTS/IN ACTUAL ENGINE OPERATING ENVIRONMENT
- MAXIMIZES OPPORTUNITY FOR STATISTICALLY MEANINGFUL OPERATING DATA BASE

MERADCOM MULTIFUEL ENGINE DEVELOPMENT

- FOR ICE, GAS TURBINE OFFERS GREATEST POTENTIAL FOR ALTERNATIVE FUEL CAPABILITY.
- MERADCOM 6.3 TECH BASE EFFORT TO APPLY CERAMIC COMPONENTS AND EXHAUST HEAT RECOVERY TO SMALL GAS TURBINES IN 10-30KW POWER APPLICABLE.

BENEFITS OF CERAMICS

- INCREASED UNCOOLED TURBINE INLET TEMPERATURE CAPABILITY

  HIGHER POWER DENSITY KW/ #
  LOWER FUEL CONSUMPTION

- ENHANCED COMBUSTION PERFORMANCE

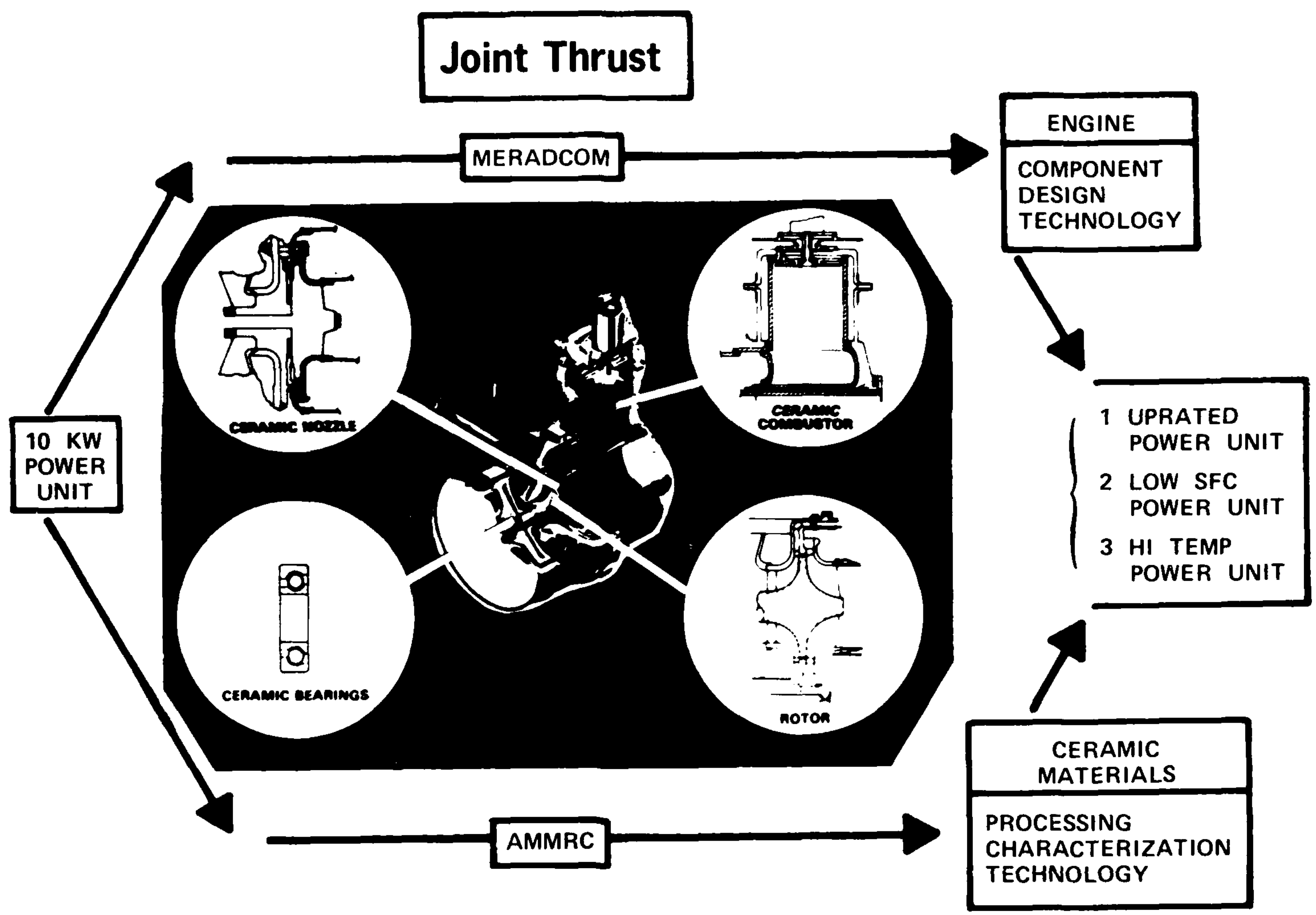
  MULTIFUEL
  LOW EMISSION

- INCREASED DURABILITY

  OVERTEMP RESISTANCE
  CORROSION/EROSION RESISTANCE

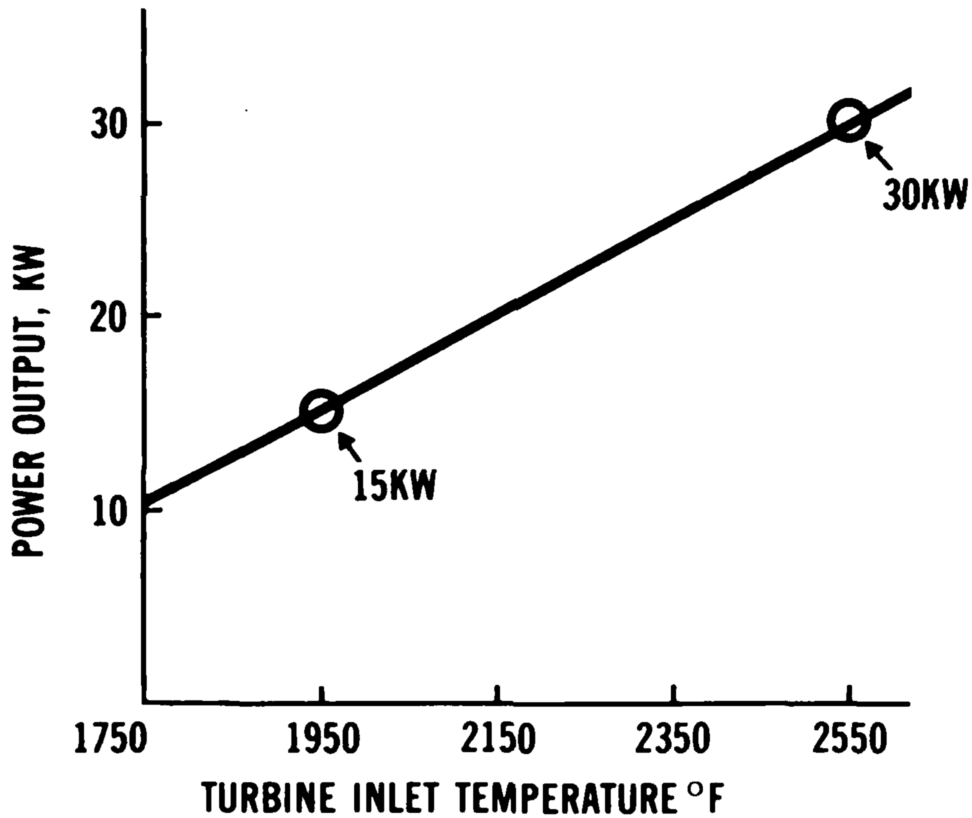
- DECREASED DEPENDENCE ON STRATEGIC MATERIALS

- REDUCED COSTS – INVESTMENT, OPERATING

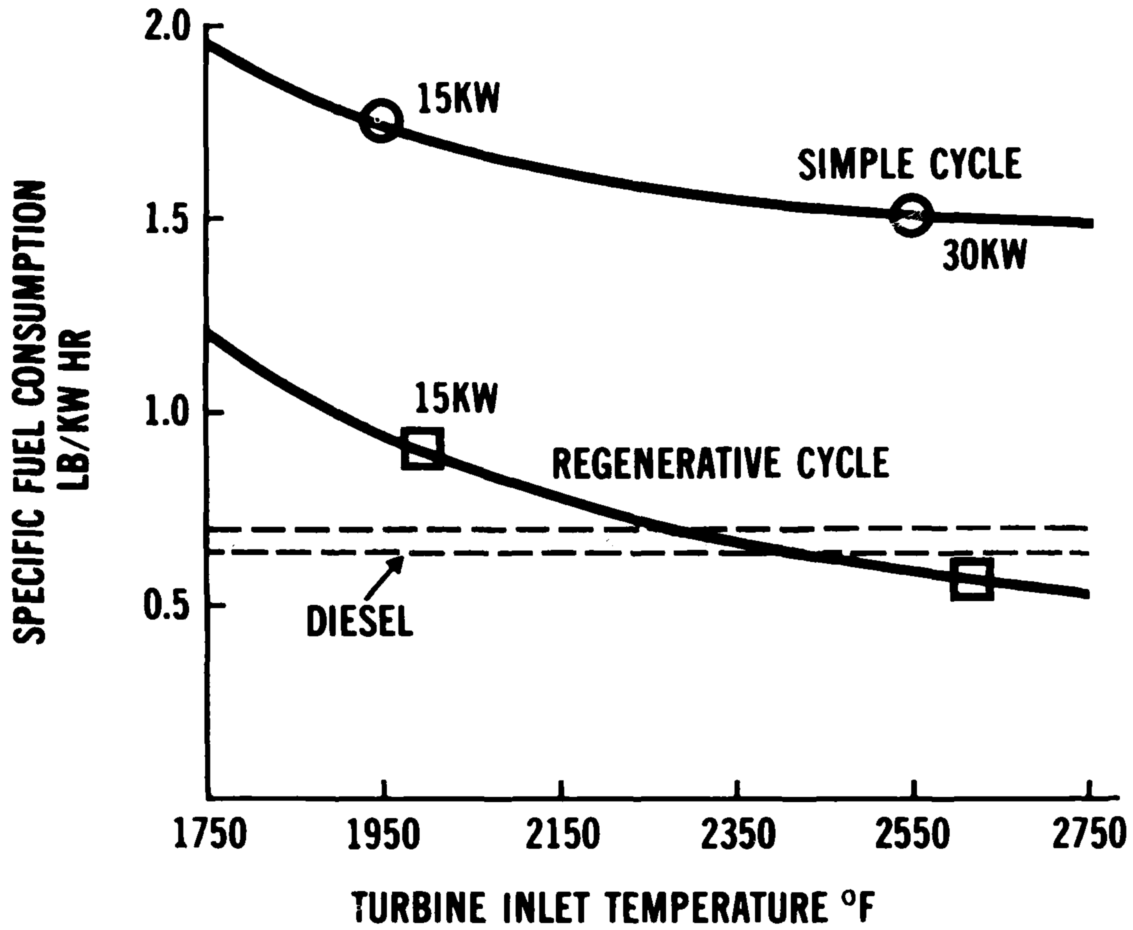


UPRATED MOBILE FIELD POWER VIA CERAMIC COMPONENTS

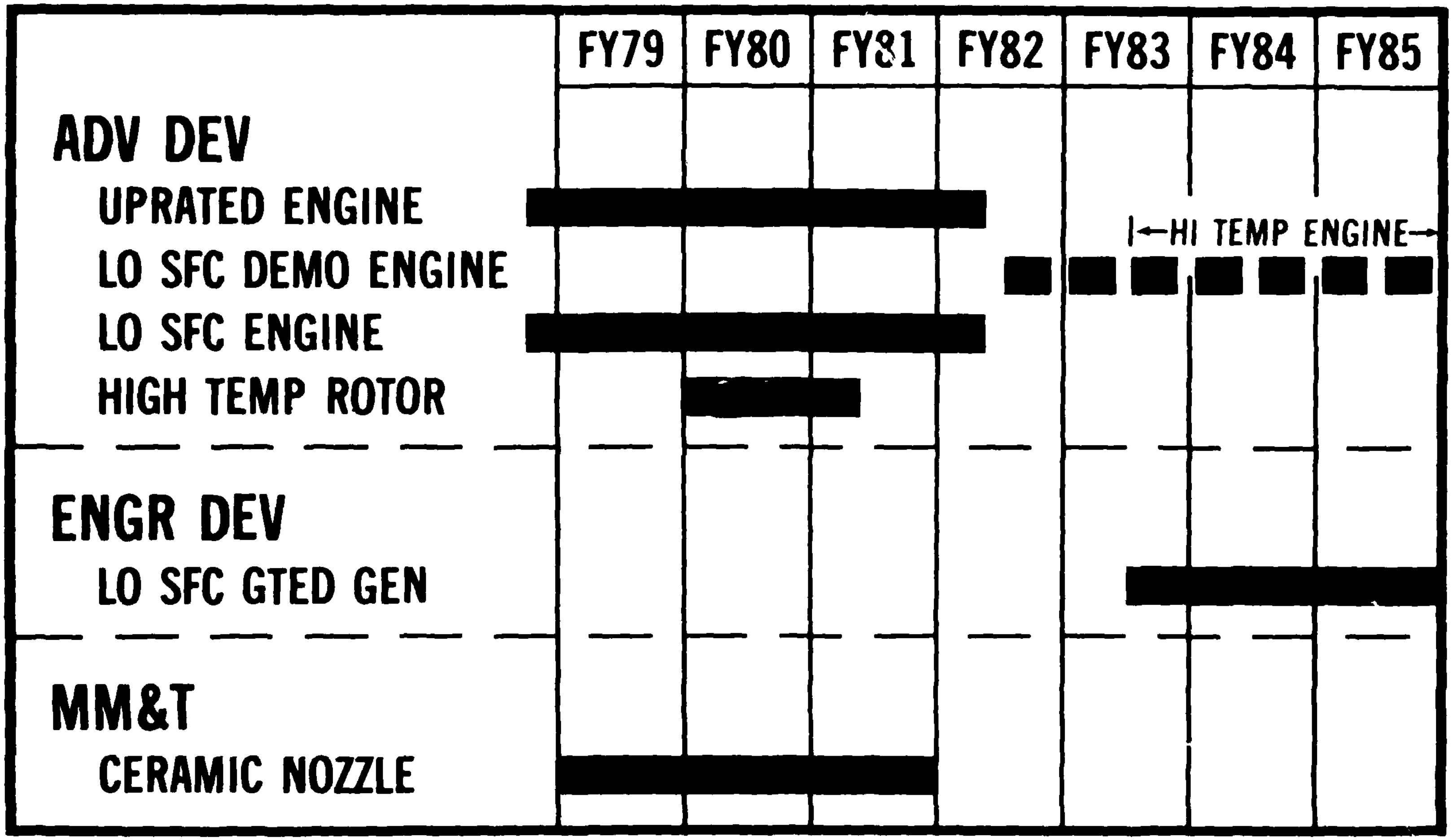
EFFECT OF TURBINE INLET TEMPERATURE ON 10KW POWER OUTPUT



EFFECT OF TURBINE INLET TEMPERATURE ON 10KW FUEL CONSUMPTION



HEAT ENGINE TECH BASE PROGRAMS



MERADCOM

MULTISOURCE—MULTIFUEL ENGINE PROGRAMS

	80	81	82	83	84	85	86
MULTISOURCE FUELS ENGINE SCREENING & TEST	500	750	250				
ALTERNATIVE FUEL COMBUSTION INVEST.	200	750	750	500	500		
MULTIFUEL ENGINE DEVELOPMENT			500	2000	2000	1500	

APPENDIX C COOPERATIVE ENERGY EFFORTS BETWEEN THE DEPARTMENT OF DEFENSE AND THE DEPARTMENT OF ENERGY

This section contains briefs and summaries related to a broad range of cooperative energy activities between the Department of Defense and the Department of Energy designed to enhance national security and achieve the United States' energy goals. DOE is the planning and management organization for federal energy programs.

INTERAGENCY AGREEMENTS UNDER THE

MEMORANDUM OF UNDERSTANDING BETWEEN DOD AND DOE

1. Number: EL-78-A-61-2815

   Subject: Storage of Strategic Petroleum Reserve

   Objective: Provide an overall assessment and report on crude/product stability for long-term strategic petroleum reserve storage.

   Funds: DOE: 157K DOD: 0

   DOD Project Office: MERADCOM, DRDME-GL

2. Number: EY-77-A-02-4162

   Subject: Stability of Hydrocarbon Fuels from Alternate Sources.

   Objective: To determine the storage characteristics of representative liquid fuels from coal, oil shale, and tar sands.

   Funds: DOE: 161K DOD: 0

   DOD Project Office: MERADCOM, DRDME-GL

3. Number: EC-76-A-31-1021

   Subject: Engine Lubricants for Use in Methanol Fueled Highway Vehicles

   Objective: To assess effects of alcohol-containing fuels on current spark ignition engine lubrication and wear. If detrimental effects do exist, develop lubricants to mitigate these alcohol-fuel effects.

   Funds: DOE: 215K DOD: 0

   DOD Project Office: MERADCOM, DRDME-GL

4. Number: EW-78-C-22-0269

Subject: R&D of Micronized Coal-Oil (MICO) as Diesel Engine Fuel

Objective: Conduct combustion experiments using Micronized Coal-oil in single cylinder diesel engine test facility and an automotive diesel engine.

Funds: DOE: 67K DOD: 0

DOD Project Office: MERADCOM, DRDME-GL

5. Number: DE-AI-01-79CS50030.00

Subject: Development of Lubrication for Alcohol Fueled Spark-Ignition Engines

Objective: Assess performance of contemporary crankcase lubricants in conventional spark ignition engines when fueled with alcohol and alcohol/gasoline blends. Resolve deficiencies and problems.

Funds: DOE: 700K DOD: 0

DOD Project Office: MERADCOM, DRDME-GL

6. Number: EC-77-A-37-1042

Subject: Evaluation of Electric and Hybrid Vehicles and Components

Objective: Establish component performance maps for the power train of an electric vehicle representative of current technology; evaluate a two-phase sequentially switched chopper motor drive system concept conceived and developed by MERADCOM.

Funds: DOE: 456K DOD: 0

DOD Project Office: MERADCOM, DRDME-EA

7. Number: DE-A101-79CS40152

Subject: Motor Efficiency Test and Evaluation

Objective: Evaluate high efficiency motors and controls.

Funds: DOE: 250K DOD: 0

DOD Project Office: MERADCOM, DRDME-EA

8. Number: EW-78-I-02-4952

Subject: Pulse Discharge Studies for Lead-Acid Batteries

Objective: Study and establish the effects of pulse discharge on battery energy, life, and microstructure with the goal of developing improved battery designs.

Funds: DOE: 100K DOD: 0

DOD Project Office: MERADCOM, DRDME-EC

9. Number: EC-77-A-03-1416

Subject: Aqueous Electrolyte Fuel Cell Research & Development

Objective: To conduct fuel cell research activities leading to improved performance and life of aqueous electrolyte fuel cells; determine the feasibility of using fuel cells in transportation applications.

Funds: DOE: 665K DOD: 0

DOD Project Office: MERADCOM, DRDME-EC

10. Number: EG-76-A-29-1031

Subject: Solar Photovoltaic Power Systems

Objective: To demonstrate the technical feasibility of solar photovoltaic power for a variety of military uses.

Funds: DOE: 2,022K DOD: 150K

DOD Project Office: MERADCOM, DRDME-ES

11. Number: DE-AI-ol-79CS30076

Subject: Federal Photovoltaic Utilization Program

Objective: To design, construct, test and install several solar cell power systems at selected Army application sites.

Funds: DOE: 1,122K DOD: 0

DOD Project Office: MERADCOM, DRDME-ES

12. Number: EC-77-A-01-1017

Subject: Heat Engine Highway Systems Materials and Components Technology

Objective: To provide technical assistance in application of advanced materials to heat engines.

Funds: DOE: Negotiable DOD: 0

DOD Project Office: AMMRC, DRXMR-EO

13. Number: E(49-28)-1007 (dated 23 Feb 76)

Subject: Enzymatic Hydrolysis of Cellulose to Glucose

Objective: Conduct research and development on the enzymatic hydrolysis of cellulosic materials to fermentable sugars.

Funds: DOE: 2,390K DOD: 1,970K

DOD Project Office: NARADCOM

14. Number: W51G213-77168-018

Subject: Storage at Tooele Army Depot

Objective: Provide storage of material in seven igloos at Pueblo Depot Activity.

Funds: DOE: 14K DOD: 0

DOD Project Office: Pueblo Depot Activity, SDSTE-PUCO

15. Number: Control Number EM78-I-01-5266

Subject: Acquisition and Testing of Electric Vehicles

Objective: Evaluate performance of electric vehicles to develop life cycle cost and energy patterns and support requirement. Develop data base for market identification and assessment. Procure five vehicles for test.

Funds: DOE: 60K DOD: 85K

DOD Project Office: TRADCOM, DRDTA-RTAV

APPENDIX D

INTERAGENCY ADVANCED POWER GROUP PROJECT BRIEFS

INTERAGENCY ADVANCED POWER GROUP PROJECT BRIEFS

1. PIC NO: New

Title: Advanced Hybrid Propulsion Program

Performing Agency: NASA-Lewis Research Center, Cleveland, Ohio

Contractor: Garrett Corporation, Torrence, CA

Objective: To provide a conceptual design of an advanced hybrid propulsion system for on-the-road vehicles.

Funds: FY79 $166K - (DOE)

2. PIC NO: New

Title: Improved AC Motor Controller for Battery Powered Urban Electric Passenger Vehicle

Performing Agency: NASA-Lewis Research Center, Cleveland, Ohio

Contractor: Gould, Inc., Rolling Meadows, IL

Objective: To develop a.c. motor controllers to take advantage of the lighter weight, lower cost, and lower maintenance of a.c. traction motors for electric vehicles.

Funds: FY79 $225K - (DOE)

3. PIC NO: 3392

Title: Advanced Electric Vehicle Motor Development

Performing Agency: NASA-Lewis Research Center, Cleveland, Ohio

Contractor: Westinghouse R&D Center, Pittsburgh, PA

Objective: Develop and demonstrate advanced electric propulsion motor for electric passenger vehicle.

Funds: FY79 $168K - (DOE)

4. PIC NO: 3406

Title: Design, Fabrication, and Test of an AC Propulsion System for an Electric Vehicle

Performing Agency: NASA-Lewis Research Center

Contractor: Eaton Corporation, Southfield, MI

Objective: To design, fabricate, and test a complete a.c. electric vehicle propulsion system for a small electric passenger vehicle.

Funds: FY79 $550K - (DOE)

5. PIC NO: New

Title: Advanced Hybrid Propulsion System Program

Performing Agency: NASA-Lewis Research Center

Contractor: South Coast Technology, Inc., Santa Barbara, CA

Objective: To provide a conceptual design of an advanced hybrid propulsion system for on-the-road vehicles.

Funds: FY79 @466K - (DOE)

6. PIC NO: New

Title: Advanced Hybrid Propulsion System Program

Performing Agency: NASA-Lewis Research Center

Contractor: Mechanical Technology Inc., Latham, NY

Objective: To provide conceptual design of an advanced hybrid propulsion system for on-the-road vehicles

Funds: FY79 $155K - (DOE)

7. PIC NO: 3369

Title: Fabrication of a State-of-the-Art Electric Vehicle Breadboard Propulsion System Using a DC Motor

Performing Agency: NASA-Lewis Research Center

Contractor: General Electric Company, Schenectady, NY

Objective: To design, fabricate, and test a propulsion system breadboard representative of the propulsion system concept developed by General Electric under contract for the near-term electric vehicle.

Funds: FY78 $360K - (DOE)

8. PIC NO: 2289

Title: Development of 10- and 20- HP, Air-Cooled, Compression Ignition Engine

Performing Agency: MERADCOM

Contractor: White Engine, Inc., Canton, Ohio

Objective: Develop a two member family of air-cooled diesel engines to have continuous load ratings of 10 and 20 hp 3600 rpm.

Funds: FY76 $120K ARMY

9. PIC NO: 2546

Title: Battery Evaluation, Testing and Duty Cycle Generation

Performing Agency: MERADCOM

Contractor: Internal

Objective: Develop battery selection criteria; perform tests on batteries to validate manufacturers battery specifications; define duty cycle. This program is related electric powered material handling equipment. These batteries have high energy density; and are designed for electric propulsion applications.

Funds: Inhouse

10. PIC NO: 2666

Title: Hybrid Power Source for Electric Propulsion

Performing Agency: MERADCOM

Contractor: Internal

Objective: To evaluate the potential of a hybrid power source (fuel cell/ battery) for electric propulsion in material handling equipment.

Funds: Inhouse

11. PIC NO: 2842

Title: Solar Cell Basic Research

Performing Agency: NASA-Lewis Research Center, Cleveland, Ohio

Contractor: Internal

Objective: To increase understanding of the basic mechanisms operating in the silicon solar cell; to increase cell efficiency.

Funds: Inhouse

12. PIC NO: 2849

Title: Advanced Thermoelectric Generator Systems

Performing Agency: ERADCOM

Contractor: Internal

Objective: To investigate and establish the feasibility of utilizing new materials and concepts to reduce unit cost in second generation liquid fueled thermoelectric power sources to power forward area Army communication-electronic equipment.

Funds: Inhouse

13. PIC NO: 3172

Title: Stirling Cycle Engine Generator Evaluation

Performing Agency: MERADCOM

Contractor: Foremade Fabrinksverke (FFV) Eskilstuna, Sweden

Objective: Evaluate performance of Stirling Cycle Engine Generator

Funds: FY76 $57K ARMY

14. PIC NO: 3213

Title: Zinc-Chlorine Battery System

Performing Agency: DOE

Contractor: Energy Development Associates, Madison Heights, MI

Objective: To continue research and development of zinc-chlorine battery system for vehicle propulsion applications.

Funds: FY77 $314K - (DOE)

15. PIC NO: 3215

Title: Lithium/Metal Sulfide Battery Development

Performing Agency: DOE

Contractor: Argonne National Laboratory, Argonne, IL

Objective: To develop lithium/metal sulfide batteries for application to electric vehicle and stationary bulk storage of electric energy.

Funds: FY77 $4600K - (DOE)

16. PIC NO: 3368

Title: Advanced Electric Propulsion System Concept for Electric Vehicles

Performing Agency: NASA Lewis Research Center

Contractor: Garrett Corporation
AiResearch Mfg Company
Torrance, CA

Objective: To provide a conceptual design of an advanced electric propulsion system for electric vehicles.

Funds: FY78 - 153K (DOE)

17. PIC NO: 3367

Title: Improved Electronically Commutated DC Motor for Electric Passenger Vehicles

Performing Agency: NASA Lewis Research Center

Contractor: Garrett Corporation
AiResearch Mfg Company
Torrance, CA

Objective: To design, fabricate, and evaluate an electronically commutated dc propulsion motor based on existing technology for use in electric passenger vehicles.

Funds: FY79 - 261K (DOE)
FY80 - 209K (DOE)

18. PIC NO: 3365

Title: Advanced DC Motor Controller for Battery Powered Electric Vehciles

Performing Agency: NASA Lewis Research Center

Contractor: Franklin Research Center, Philadelphia, PA.

Objective: To develop the concept of controlling the speed and torque of a dc traction motor with advanced type rotating machines and demonstrate with a functional model controller sized for a four-passenger vehicle.

Funds: FY78 - 199K (DOE)

19. PIC NO: 3391

Title: Development of an Improved Electronically Commutated DC Motor for Electric Passenger Vehicles

Performing Agency: NASA Lewis Research Center

Contractor: Virginia Polytechnic Institute and State University, Blacksburg, VA

Objective: To design, fabricate, and evaluate and electronically commutated dc motor based on existing technology specifically for use in electric passenger vehicles.

Funds: FY79 - 140K (DOE)

20. PIC NO: 3341

Title: Advanced High-Output Diesel Demonstrator

Performing Agency: TRADACOM

Contractor: Cummins Engine Company
Columbus, IN

Objective: To demonstrate the application of advanced diesel engine technology to a production base engine to provide a compact efficient engine for military applications.

Funds: FY79 - 400K (Army)

21. PIC NO: 3266

Title: Adiabatic Diesel Engine Program

Performing Agency: TARADCOM

Contractor: Cummins Engine Company
Columbus, IN

Objective: To produce an engine which essentially insulates the diesel combustion chamber using high temperature to allow "hot" operation near an adiabatic operation condition. This allows improved efficiency through turbo charging and turbo compounding and reduced weight through elimination of conventional cooling system components.

Funds: FY79 - 450K (Army)

22. PIC NO: 3335

Title: Combustion Optimization Studies for Stratified Charge and Diesel Engines

Performing Agency: U.S. DOE

Contractor: Princeton University
Princeton, NJ

Objective: This is a cooperative effort of several laboratories in direct injected stratified charge engines.

Funds: FY 78 - $160,000 FY79 - $165,000 (DOE)

23. PIC NO: 3343

Title: Coal Combustion for Cogeneration (CCC)

Performing Agency: DOE

Contractor: Oak Ridge National Laboratory
Oak Ridge, TN

Objective: CCC will be investigated to determine its potential in Commercial/Industrial applications and to investigate the advantages of fluidized-bed combustion when coupled with a closed cycle gas turbine.

Funds: FY77 & prior 4,225K, (ERDA) FY78 - 2,000K (DOE) FY79 1,000K (DOE)

24. PIC NO: 3351

Title: Advanced High - Output Diesel Demonstrator

Performing Agency: U.S. Army Tank-Automotive Research and Development Command (TARADCOM)

Contractor: Cummings Engine Company
Columbus, OH

Objective: This program demonstrates the ability to apply advanced diesel engine technology (injection systems high pressure, high efficiency turbochargers, turbo-compounding) to a production base engine of a normal 900HP. The same production base engine can cover the 900 - 1000 HP range by varying designed configurations. The result will be an engine that approaches a design specifically military oriented but costs approximately 50% less.

Funds: FY78 274K FY79 400K. (Army)

25. PIC NO: 3266

Title: Adiabatic Diesel Engine Program

Performing Agency: U.S. Army Tank Automotive Research and Development Command (TARADCOM)

Contractor: Cummings Engine Company
Columbus, OH

Objective: The Adiabatic Diesel Engine Program is designed to produce an engine which essentially insulates the diesel combustion chamber using high temperature materials and thus allowing "hot" operating near an adiabatic operating condition. Energy normally lost to cooling water and exhaust gas is converted to useful power through the use of turbomachinery and high temperature materials.

Funds: FY77 - 250,000 FY78 - 290,000 FY79 - 450,000 (Army)

26. PIC NO: 3227

Title: Cabitation Damage Mechanisms

Performing Agency: Air Force Aero Propulsion Laboratory
Wright-Patterson AFB, OH

Contractor: Georgia Institute of Technology
School of Engineering, Atlanta, GA

Objective: To develop analytical capability for predicting occurrance of cavitation in hydraulic systems and to establish its effects on component and/or system performance.

Funds: FY77 - 10,000, FY78 - 82,900, FY79 - 3000 (USAF)

27. PIC NO: 3226

Title: High performance APU Technology Demonstrator

Performing Agency: AF Propulsion Branch
Wright Patterson AFB, OH

Contractor: AVCO/Lycoming 550 South Main Street
Stratford, CT

Objective: To develop a high performance Auxiliary Power Unit (HPAPU) Technology Demonstrator. The HPAPU will be based upon the existing AVCO/Lycoming LTS101 turbomachine to minimize development risks.

Funds: FY77 1,400,000 (USAF)
FY78 866,000 (USAF)
FY79 585,000 (USAF)

28. PIC NO: 2851

Title: Multi-purpose missiles (MPM)
Flight Vehicle Power Systems

Performing Agency: Air Force Aero Propulsion Laboratory
Wright Patterson AFB, OH

Contractor: The Marquardt Company
16555 Saticoy Street
Van Nuys, CA

Objective: To develop the technology required to provide electrical, hydraulic and fuel pump power for a missile of multi-purpose missile type.

Funds: FY75 - 220,000, FY76 - 355,000
FY77T - 90,000, FY77 - 318,000
FY78 - 12,395 (USAF)

29. PIC NO: 2016

Title: Marine Tribology - Improved Lubricating Fluids for Ships Service

Performing Agency: David Taylor Naval Ship R&D Center
Annapolis, Maryland

Contractor: None - Internal

Objective: To develop predicitive characterization criteria for Lubricating oil-base stock additive requirements to provide a process of qualifying lubricating oils without constant base stock assumption.

Funds: No contact funding

APPENDIX E

NON RDT&E EFFORTS

MANUFACTURING METHODS AND TECHNOLOGY

1. Performing Activity: MERADCOM

   Project No: E813716

   Title: Kocite[R] Derived Electrods for Fuel Cells

   Description: Development of fabrication techniques for advanced fuel cell catalysis and electrodes.

   Funds:

FY80	FY81
$210K	$130K

2. Performing Activity: MERADCOM

   Project No: E813717

   Title: High Temperature Nozzle

   Description: Reduce cost of cast ceramic nozzle for gas turbine engine generator set. Improve power output and fuel economy of turbine engine.

   Funds:

FY78	FY79	FY80	FY81
$343K	0	$400K	$503K

3. Performing Activity: MERADCOM

   Project No: OPA3532

   Title: PBS-MM&T Molten Salt Li/Cl Batteries

   Description: Development and evaluation of Li/Cl batteries. Batteries to be used in electric fork lift.

   Funds:

FY79	FY80
$291K	$15K

4. Performing Activity: MERADCOM

   Project No: E813772

   Title: Integrated Power Switch (IPS)

   Description: Develop fabrication techniques for integrated power switch consisting of power transistors, base drive circuitry and protective circuitry, all mounted on common heat sink. IPS to be used in power conditioning equipment.

   Funds:

FY81
$370K

5. Performing Activity: AVRADCOM

Project No: 1817143

Title: Ceramic High-Performance Gas Path Seal

Description: Improve gas turbine engine fuel efficiency and power through use of ceramic seal that allows higher operating temperature.

Funds:

FY81
$300K

6. Performing Activity: TRADCOM

Project No. T816000

Title: Lightweight Hood and Fenders

Description: Develop fabrication techniques for lightweight composite fender and hood assemblies for five ton and five ton PIP vehicle. Improve performance and reduce fuel consumption.

Funds:

FY79	FY80	FY81
$300K	$387K	$200K

7. Performing Activity: TRADCOM

Project No: T815053

Title: Fabrication Techniques for High-Strength Ceramics

Description: Develop fabrication techniques for ceramic components for advanced adiabatic diesel engine.

Funds:

FY81	FY82	FY83	FY84	FY85
$250K	$250K	$200K	$200K	0

MILITARY ADAPTATION OF COMMERCIAL ITEMS

(MACI)

1. Performing Activity: TARADCOM

   Project No: T814301

   Title: Commercial Engines and Emission Control Device

   Description: Evaluate commercial engines for military applications. Reduce fuel consumption of military vehicles.

   Funds:

FY79	FY80	FY81	FY82	FY83	FY84	FY85
$450K	$100K	(500K)	(550K)	(550K)	(550K)	(550K)

2. Performing Activity: TRADCOM

   Project No: T816003

   Title: Analysis of Radial Tires Versus Bias Tires

   Description: Evaluation of radial tires versus bias tires on military vehicles for reducing fuel consumption.

   Funds:

FY89	FY80	FY81	FY82
$450K	$200K	0	0

3. Performing Activity: TARADCOM

   Project No: T794331/T814331

   Title: Evaluate Commercial Trucks for Tactical Applications

   Description: Evaluate use of electric drive vehicle on military posts, camps, and stations. Reduce use of petroleum fuels.

   Funds:

FY79	FY80	FY81	FY82
$63K	$27K	$27K	$27K

4. Performing Activity: TARADCOM

Project No: T804501

Title: Transmission and Transfer Assemblies

Description: Evaluate use of state-of-the-art commercial transmissions and transfer assemblies in military vehicles to improve efficiency of propulsion system and reduce fuel consumption.

Funds:

FY79	FY80	FY81	FY82	FY83	FY84	FY85
$365K	$282K	(420K)	(440K)	(460K)	(460K)	(470K)

5. Performing Activity: MERADCOM

Project No: (Proposed)

Title: Energy Efficiency Analysis for Mobile Construction Equipment

Description: Develop a comparative analysis process for evaluating energy efficiency of mobile construction equipment to allow selection of energy efficient commercial construction equipment.

Funds:

FY80	FY81	FY82	FY83	FY84
(300K)	(500K)	(500K)	(300K)	(100K)

6. Performing Activity: MERADCOM

Project Number: (Proposed)

Title: Non-Petroleum Hydraulic Fluids in Construction and Material Handling Equipment

Description: Evaluate and prepare for transition to the use of non-petroleum hydraulic fluids in construction and material handling equipment.

Funds:

FY80	FY81	FY82	FY83	FY84
(150K)	(200K)	(200K)	(150K)	(150K)

7. Performing Activity: MERADCOM

Project No: (Proposed)

Title: Hybrid Fuel Cell Powered Material Handling Equipment

Description: Determine the feasibility of the use of hybrid fuel cell to power material handling equipment.

Funds:	FY80	FY81	FY82	FY83	FY84
	(200K)	(225K)	(250K)	(300K)	(350K)

8. Performing Activity: TARADCOM

Project No: T806024

Title: Commercial Power Sources for Combat Vehicles (Phase I)

Description: Validation of engine performance and durability of selected high technology advanced commercial engines. Program will provide technology base for militarized commercial engines with improved performance and economy.

Funds:	FY80	FY81	FY82	FY83	FY84	FY85
	$100K	($500K)	($650K)	($700K)		

CATEGORY II

Supportive Energy Conservation Projects

MACI ENGINE PROGRAM

OBJECTIVE AND EXPECTED PAYOFF:

Select and test commercial engine candidates to evaluate their acceptability and to define required modifications for military applications. Will result in a 5 percent reduction in fuel consumption.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent. Improved efficiency of propulsion systems.

STOG REFERENCE:

79.3.2.0, 79-7.1.12.

APPROACH:

Commercial engines which have a high potential for military application will be tested. The testing will be targeted to determine the performance/installation characteristics and durability under military conditions.

FUNDING	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
MACI	4301	0	120K	(500K)	(550K)	(550K)	(550K)	(550K)

COMMAND:

TARADCOM

CATEGORY II

Supportive Energy Conservation Projects

MACI - TRANSMISSIONS AND TRANSFER ASSEMBLIES

OBJECTIVE AND EXPECTED PAYOFF:

The objective of this project is to apply the latest state of technology components available from the commercial make to military wheeled vehicles for technical evaluation and assessment. Will result in a five percent reduction in fuel use.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operation by 10 percent. Improved efficiency of propulsion systems.

STOG REFERENCE:

79.3.3.0, 79.7.1.12.

APPROACH:

Commercial transmissions and transfer cases will be tested for application to tactical wheeled vehicles. The testing will determine the performance/installation characteristics and durability under military conditions.

FUNDING:	DA PROJECT NUMBER	FY79	FY80	FY81	FY82	FY83	FY84	FY85
MACI	1L263621D607	$365K	$282K	(420)	(440)	(460)	(460)	(470)

COMMAND:

TARADCOM

PRODUCT IMPROVEMENT PROGRAM

Performing Activity: TARADCOM

Project No: 1-77-05-6501

Title: M113 PIP

Description: Improve the M113E1 armored personnel carrier performance and fuel economy through use of Allison X200 transmission.

Funds: <u>FY79</u>
$300K

CATEGORY II

Supportive Energy Conservation Projects

M113 PIP

OBJECTIVE AND EXPECTED PAYOFF:

To improve the power plant efficiency of the M113A1 Armored Personnel Carrier. Improved fuel economy and operation efficiency.

DA GOAL(S) SUPPORTED AND DOD ENERGY SPECIAL INTEREST AREA(S) SUPPORTED:

Reduce energy consumption in mobility operations by 10 percent. Improve efficiency in propulsion systems.

STOG REFERENCES:

PIP 1-77-05-6501

APPROACH:

Five test vehicles have accumulated 27,533 miles of DT and OT testing. During the DT testing at APG, a comparison performance test was conducted between the M113E1 and the M113A1 vehicles. The M113E1 had an average fuel consumption improvement of 9 percent and a maximum improvement of 27 percent over the cross-country (Perryman 3) course. The Allison X200 transmission is responsible for a large portion of the improvement. The production decision will be made at the IPR in September 1979.

FUNDING	DA PROJECT NUMBER	FY79
PEMA	17705650152	$300K

COMMAND:

TARADCOM

APPENDIX F

AMMUNITION PLANTS

This appendix contains some information concerning energy at the DARCOM Ammunition Plants. During the next year, it will be integrated into the Facilities Energy Section.

DEPARTMENT OF THE ARMY
US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
DOVER, NEW JERSEY 07801

AUG 22 1979

DRDAR-TD

SUBJECT: DARCOM Energy R&D Plan

Commander
US Army Mobility Equipment Research & Development Command
ATTN: DRDME-ES
Fort Belvoir, VA 22060

1. In response to your letter of 18 June 1979, subject as above, energy research and development for mobility operations is not within the mission of ARRADCOM. Compared to the requirements of MERADCOM, TARADCOM or AVRADCOM, the use of mobility fuels within our Command is very small. Thus, we do not have any energy R&D projects to submit.

2. However, ARRADCOM is involved in two other aspects of the overall energy program: a) conservation of energy at Army ammunition plants and b) DARCOM energy conservation. Short discussions of each of these areas are contained in inclosures 1 and 2, respectively.

3. In the recent past one of our laboratories, Chemical Systems Laboratory (CSL) at Aberdeen Proving Ground, MD, had a group that was involved in engineering support work for the Department of Energy. Even though this group has not been functional for several months, they have made several suggestions that are listed below for your consideration.

a. The Department of Energy is currently supporting industry in programs to determine the commercial feasibility of several processes for converting coal and shale into more readily useable gaseous and liquid fuels. It should be possible for the Army to join in ghis support by furnishing resources to increase the capacity of facilities already on the drawing board. This increased capacity, in turn, would provide the Army with a greater supply of synthetic natural gas and oil for expanding the production base in event of mobilization.

DRDAR-TD AUG 29 1979
SUBJECT: DARCOM Energy R&D Plan

b. The Army should examine the merits of a program to develop, conduct, and operate an Army coal conversion plant or plants to provide for its future needs. An ideal location for such a plant would be an existing Army installation such as Radford Army Ammunition Plant. In cases where synthetic natural gas would be produced at such a plant, the products might be ingested into the national pipelines distribution system, enabling the Army to withdraw "credits" from the pipeline at other Army plant locations around the country. Similar possibilities might be otained with plants that would turn out synthetic liquid fuels for use in producing military material. Attached as inclosure 3 is a plan for developing a coal conversion facility at ARRCOM's Radford AAP as proposed by Mr. Hugh Reilly, former Chief of the DOE Support Office at CSL, ARRADCOM. The ARRCOM Energy Conservation Committee has been briefed on this proposal by Mr. Reilly.

4. ARRADCOM is not seeking the mission or resources to undertake such a project as outlined in 3.b., above, but rather we simply offer the suggestion as an interesting possibility. Further inquiries regarding any of the items discussed above should be addressed to Parker Ferguson, ARRADCOM Executive Fellowship Office, AUTOVON 880-4508.

FOR THE COMMANDER:

3 Incl
as

ROBERT E. WEIGLE
Technical Director

CONSERVATION OF ENERGY AT ARMY AMMUNITION PLANTS

A Manufacturing Methods & Technology (MMT) energy conservation technology program assigned to ARRADCOM's Large Caliber Weapons Systems Laboratory (LCWSL) has been in effect for the past three years to accomplish the dual purpose of: (1) reducing the cost of munitions manufacturing and loading at the Army Ammunition Plants and (2) conserving our dwindling fossil fuel resources. This project, which supports the munitions modernization and expansion program, specifically addresses the energy that is consumed in the manufacturing operations that take place in the plants. The program is organized to: (1) survey the energy consumption on a unit operation/process basis; (2) introduce energy conservation technology that will result in reduced energy consumption per unit of product manufactured; and (3) adapt alternate sources of energy to plant operations in order to reduce dependence on fossil fuels. Examples of areas of conservation technology are: (1) recovery of waste heat generated by exothermic chemical reactions and other process sources; and (2) process modifications to reduce energy consumption. Alternate sources of energy being considered for the plants are: (1) use of biomass as a primary fuel; (2) use of solar energy for process heating applications; and (3) use of synthetic natural gas from coal for propellant related process operations.

Incl 1

DARCOM Energy Conservation

These are energy initiatives which are available and which should be explored by DARCOM. Assuming the thrust to be the reduction of energy consumption related to oil, the following should be sponsored to DA.

a. A special construction program (not MCA) to accelerate conversion of DARCOM power plants and heating plants from oil to coal. ARRADCOM has already proposed same for our boilers. At this time we have been advised to let the plan proceed as originally scheduled.

b. Revision of the Army Facilities Energy Plan dated Oct 78 and the Energy Conservation Investment Program (ECIP) Guidance such that earlier consideration is given to projects which fall below the current 1978 guidance Energy to Cost ratio. Consideration must also be applied to the reduction of the minimum benefit to cost rations below the currently established 1.0 minimum. ARRADCOM has a significant number of ECIP projects proposed.

Incl 2

Army Operation of Coal Conversion to Gaseous/Liquid Energy Plants

1. To illustrate the potential inherent in placing a coal conversion plant at one or more of the Army's industrial ammunition plants, a look at Radford AAP will serve to put such a program into proper focus.

2. Radford AAP, located in Radford, Virginia, which is in the southwestern corner of the state, is a large chemical manufacturing complex responsible for the manufacture of propellants and explosives for military munitions. In addition to the primary manufacturing processes, Radford also produces, recovers and concentrates the acids used within the plant. The enormous amount of energy used in these manufacturing operations can be seen in Table 1, which summarizes the actual fuel consumption for the 1970-75 period at production levels well below mobilization. This information is provided for both the present mode of operation and for the post modernization period, which reflects the completion of the current effort to modernize the production and support facilities at Radford. As part of the total fuel requirement, Radford uses a large amount of natural gas directly for their process operations. During times of curtailments and reduced allocations, only a few of these operations can shift to a secondary fuel. The processes which require gaseous fuel with their daily consumption rates under mobilization are listed in Table 3.

3. Many factors support the choice of such a site for a coal conversion plant. In addition to the valid energy requirement for the product fuel gas, other factors for consideration are:

a. Government owned and controlled installation. The fuel gas would be located on and used by a government defense installation, thus providing direct cognizance of the fuel gas plant operations.

b. Use for inert by-products. If the selected coal gasification process requires oxygen feeding, the nitrogen gas from the associated air separation plant could be used in place of the currently generated inert gas that is required in a number of the process operations.

c. Use of high sulfur coal. Coal that produces a high sulfur fuel gas can be used effectively at Radford. The Sulfuric Acid Regeneration Plan (SAR) requires the addition of elemental sulfur for the production of oleum. The SAR could use both the fuel gas without H_2S separation and also the H_2S gas, extracted from fuel gas for specific low sulfur requirements.

4. In view of the large energy usage and its unique manufacturing operations as a government-owned industrial facility, Radford AAP should be examined as a possible site for an industrial fuel gas plant to provide fuel gas for all of the plant energy requirements.

Incl 3

Table 1
Radford Army Ammunition Plant
Historical Fuel Consumption
Quantity/Year

	CY70	CY71	CY72	CY73	CY74	CY75
Coal (Tons)	269,340	254,916	232,696	238,104	214,584	144,703
Fuel Oil (Gals)	319,752	290,256	2,432,952	1,323,408	2,494,164	1,810,000
Natural Gas (M CuFt)	56,404	24,192	37,295	340,836	402,768	68,864
Liquified Petroleum Gas[1] (Gals)	70,248	61,212	153,904	229,740	471,432	279,778
Electricity						
Generated (KWH)	146,471,100	136,912,000	113,404,000	123,143,100	111,198,190	60,761,659
Purchased (KWH)	11,285,000	12,385,000	42,984,000	36,863,000	31,833,000	26,876,000
Total Energy Input[2] (10^9 BTU)	7,729	7,300	7,289	7,570	7,113	4,692

[1] LPG represents a composite of propane and butane.

[2] Only purchased electricity included and 33% efficiency for utility fuel to electricity conversion.

Table 2
Fuel Usage at Mobilization
(Quantity/Year)

Fuel	Present Facilities	Post Modernization (1985)
Coal (Tons)	337,000	505,000
Fuel Oil (Gals)	8,351,000	9,315,000
Natural Gas (M CuFt)	924,240	1,235,700
Liquified Petroleum Gas[1] (Gals)	1,816,000	6,964,000
Total Energy Input[2] (10^9 BTU)	11,684	17,313

[1] LBG represents a composite of propane and butane.

[2] Does not include purchased electricity.

Table 3

Gaseous Fuel Requirements

	CUFT/DAY[1] AT MOBILIZATION
Sulfuric Acid Regeneration (SAR)	4,800,000
Ammonia Oxidation Plant (AOP)	720,000
Nitric Acid-Sulfuric Acid	
Concentrator (NASAC)	552,000
Red Water Incineration	160,000
Inert Gas Plant	136,000
Decontamination Oven	104,000
TOTAL	6,472,000

[1] Natural Gas @ 1030 BTU/Cu ft.

APPENDIX G

GLOSSARY OF TERMS

AAP -	ARMY AMMUNITION PLANT
AEO -	ARMY ENERGY OFFICE
AERDP -	ARMY ENERGY RESEARCH AND DEVELOPMENT PROGRAM
AGE -	ADVISORY GROUP ON ENERGY
API -	AMERICAN PETROLEUM INSTITUTE
AR -	ARMY REGULATION
ARNG -	ARMY NATIONAL GUARD
ASA (IL&FM) -	ASSISTANT SECRETARY OF THE ARMY (INSTALLATION LOGISTICS, AND FINANCIAL MANAGEMENT)
ASD (MRA&L) -	ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS, AND LOGISTICS)
ATS -	ANNUAL TRAINING SITE
BTU -	BRITISH THERMAL UNIT
CERL -	CONSTRUCTION ENGINEERING RESEARCH LABORATORY
CIA -	CENTRAL INTELLIGENCE AGENCY
CNGB -	CHIEF, NATIONAL GUARD BUREAU
COE -	CHIEF OF ENGINEERS
CONUS	CONTINENTAL UNITED STATES
CPA -	CHIEF OF PUBLIC AFFAIRS
CRF -	COMBAT READINESS FLYING
CSR -	CHIEF OF STAFF REGULATION
DA -	DEPARTMENT OF THE ARMY
DARCOM -	UNITED STATES ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND

DASD (EE&S) -	DEPUTY ASSISTANT SECRETARY OF DEFENSE (ENERGY, ENVIRONMENT, AND SAFETY)
DCSLOG -	DEPUTY CHIEF OF STAFF FOR LOGISTICS
DCSOPS -	DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
DCSPER -	DEPUTY CHIEF OF STAFF FOR PERSONNEL
DCSRDA -	DEPUTY CHIEF OF STAFF FOR RESEARCH, DEVELOPMENT, AND ACQUISITION
DEIS -	DEFENSE LOGISTICS AGENCY
DOD -	DEPARTMENT OF DEFENSE
DOE -	DEPARTMENT OF ENERGY
ECD -	EXPECTED COMPLETION DATE
ECIP -	ENERGY CONSERVATION INVESTMENT PROGRAM
ECRAS -	ENERGY CONSUMPTION, REPORTING AND ANALYSIS SYSTEM
ECS -	EQUIPMENT CONCENTRATION SITE
EPA -	ENVIRONMENTAL PROTECTION AGENCY
EQ/ECIP -	EQUIPMENT ENERGY CONSERVATION INVESTMENT PROGRAM
ERDA -	ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
FEA -	FEDERAL ENERGY ADMINISTRATION
FHMA -	FAMILY HOUSING MANAGEMENT ACCOUNT
FORSCOM -	UNITED STATES ARMY FORCES COMMAND
FY -	FISCAL YEAR
GNP -	GROSS NATIONAL PRODUCT
GSA -	GENERAL SERVICES ADMINISTRATION
HHG -	HOUSEHOLD GOODS
HQAFSC -	HEADQUARTERS, AIR FORCE SYSTEMS COMMAND
HQDA -	HEADQUARTERS, DEPARTMENT OF THE ARMY

HTGR -	HIGH-TEMPERATURE GAS COOLED REACTOR
I&M -	INSPECTION AND MAINTENANCE
ILS -	INTEGRATED LOGISTIC SUPPORT
IPR -	IN-PROCESS REVIEW
KW -	KILOWATT
LMFBR -	LIQUID METAL FAST BREEDER REACTOR
LPG -	LIQUIFIED PETROLEUM GAS
MACOM -	MAJOR COMMAND
MBTU -	MILLION BRITISH THERMAL UNIT
MCA -	MILITARY CONSTRUCTION, ARMY
MCAR -	MILITARY CONSTRUCTION, ARMY RESERVES
MCARNG -	MILITARY CONSTRUCTION, ARMY NATIONAL GUARD
MERADCOM -	MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT COMMAND
MILCON -	MILITARY CONSTRUCTION
MMT -	MANUFACTURING METHODS AND TECHNOLOGY
MTT -	MANUFACTURING TESTING TECHNOLOGY
NAE -	NATIONAL ACADEMY OF ENGINEERS
NARADCOM -	NATIONAL RESEARCH AND DEVELOPMENT COMMAND
NAS -	NATIONAL ACADEMY OF SCIENCES
NGB -	NATIONAL GUARD BUREAU
OACSI -	OFFICE, ASSISTANT CHIEF OF STAFF FOR INTELLIGENCE
OAPEC -	ORGANIZATION OF ARAB PETROLEUM EXPORTING COUNTRIES
OASA (IL&FM) -	OFFICE, ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, LOGISTICS, AND FINANCIAL MANAGEMENT)
OASD (MRA&L) -	OFFICE, ASSISTANT SECRETARY OF DEFENSE (MANPOWER, RESERVE AFFAIRS, AND LOGISTICS)

OCA -	OFFICE, COMPTROLLER OF THE ARMY
OCE -	OFFICE, CHIEF OF ENGINEERS
OCAR -	OFFICE, CHIEF ARMY RESERVE
OCNGB -	OFFICE, CHIEF NATIONAL GUARD BUREAU
LDCSLOG -	OFFICE, DEPUTY CHIEF OF STAFF FOR LOGISTICS
ODCSOPS -	OFFICE, DEPUTY CHIEF OF STAFF FOR OPERATIONS
ODCSPER -	OFFICE, DEPUTY CHIEF OF STAFF FOR PERSONNEL
ODSCRDA -	OFFICE, DEPUTY CHIEF OF STAFF FOR RESEARCH, DEVELOPMENT, AND ACQUISITION
OJCS -	OFFICE, JOINT CHIEFS OF STAFF
OMA -	OPERATION AND MAINTENANCE, ARMY
OPEC -	ORGANIZATION OF PETROELUM EXPORTING COUNTRIES
OSD -	OFFICE OF THE SECRETARY OF DEFENSE
OTSG -	OFFICE OF THE SURGEON GENERAL
PAED -	DIRECTORATE OF PROGRAM AND ANALYSIS, OFFICE OF THE CHIEF OF STAFF
PDM -	PROGRAM DECISION MEMORANDUM
POC -	POINT OF CONTACT
POL -	PETROLEUM
POM -	PROGRAM OBJECTIVES MEMORANDUM
QRIP -	QUICK RETURN ON INVESTMENT PROGRAM
R&D -	RESEARCH AND DEVELOPMENT
RDF -	REFUSE-DERIVED FUEL
RDT&E -	RESEARCH AND DEVELOPMENT TEST AND EVALUATION
SAG -	STUDY ADVISORY GROUP

SFTS -	SYNTHETIC FLIGHT TRAINING SYSTEM
SGFP -	US ARMY HEALTH FACILITY PLANNING AGENCY
SPR -	STRATEGIC PETROLEUM RESERVE
STOG -	SCIENCE AND TECHNOLOGY OBJECTIVES GUIDE
TARADCOM -	TANK AUTOMOTIVE RESEARCH AND DEVELOPMENT COMMAND
TECOM -	UNITED STATES ARMY TEST AND EVALUATION COMMAND
TRADOC -	UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
TSG -	THE SURGEON GENERAL
UFR -	UNFUNDED REQUIREMENTS
UH -	UTILITY HELICOPTER
USALEA -	UNITED STATES ARMY LOGISTICS EVALUATION AGENCY
USAEIGHT -	EIGHTH UNITED STATES ARMY
USAR -	UNITED STATES ARMY RESERVE
USAREUR -	UNITED STATES ARMY, EUROPE
USGS -	UNITED STATES GEOLOGICAL SURVEY

APPENDIX H. REFERENCES AND BIBLIOGRAPHY

1. Army Energy Plan, 24 February 1978 with change 1, 15 September 1978, Office of the Deputy Chief of Staff for Logistics, Army Energy Office, Headquarters, Department of the Army, Washington, DC 20310.

- The Plan identifies the Army's organization, goals, objectives, and policies with respect to energy. It projects energy consumption and costs to the year 2000 and summarizes the programs required to support the long range goals. A summary of current and needed energy related legislation is included.

2. Letter DAMA-PPM, dated 8 May 1979. Subject: Mobility Operations Energy Research and Development.

- It requested DARCOM to develop a Coordinated Mobility Operations Energy R&D Plan to meet the DOD and Army Energy goals.

3. Unpublished report, "Army Mobility Energy Investment Strategy," MERADCOM Energy Systems Project Office, May 1979.

- Draft report presenting a view of the Army's role in the DOD Energy Program, analysis of current programs, national security implications of the energy threat, strategy issues and recommendations.

4. Defense Energy Program Policy Memorandum (DEPPM) No. 78-6 dated 2 October 1978, Assignment of Lead Service Responsibilities for Energy Technologies.

- Discussion of energy policy in relationship to coordination and management of DOD to meet national energy goals and DOD mission. Assignment of Lead Service responsibilities for energy technology.

5. Army Policy Statement on Mobility Energy Research and Development, dated 22 December 1978. (Assistant Secretary of the Army, Research Development and Requisitions)

- Establishes Army policy on mobility energy research and development. The Army encourages research for massive production of synthetic mobility fuels for early type classification and use in Army equipment. It encourages R&D to improve fuel efficiency of equipment through new design and economic retrofit of old equipment and R&D to permit development of systems capable of using a broad range of synthetic and conventional fuels.

14. DEPPM 78-3, Revised Defense Energy Management Actions for 1978, 17 May 1978.

- This policy memorandum establishes a list of revised defense energy management priorities for 1978.

15. DEPPM 78-4, Department of Defense Energy Awareness Program, 28 June 1978.

- This policy memorandum establishes guidance for energy awareness programs in DOD.

16. DEPPM 78-5, Defense Photovoltaic Program Office Charter, 13 July 1979.

- Establishes Defense Photovoltaic Program Office responsibility for coordination of photovoltaic programs in the military services including the review of programs, bedgeting, and central point of contact with DOE.

17. DEPPM 78-7, Energy Conservation in Transportation, 15 December 1978.

- A policy on energy conservation in transportation with emphasis on traffic management, equipment maintenance, operations, and training.

18. DEPPM 79-1, Defense Energy Management Priorities for 1979, 12 January 1979.

- A list of defense energy management priorities for 1979 with emphasis on assuming DOD mobility fuel supplies, planning for the development of and transition to the use of synthetic and alternate mobility fuels, cooperative efforts in energy with DOE, and achieving the national and DOD energy conservation goals.

19. DEPPM 79-4, Department of Defense Energy Conservation Baselines, 30 April 1979.

- A policy establishing procedures for measuring performance against energy conservation goals of Executive Order 12003.

20. DEPPM 79-5, 1979 Defense Energy Management Priority No. 1 Fuel Supply Assurance, 17 April 1979.

- This policy memorandum promulgates the work action plan to assure the uninterrupted supply of fuels to meet military requirements. The action plan will develop decision matrices for various fuel interruption scenarios and will develop policy documents to authorize specific actions.

21. Energy Section of the Systems Acquisitions Study (Doomsday), USAF, 30 April 1979.

- An Air Force briefing which provides a perspective on the energy problem including a review of world and domestic petroleum picture, domestic energy alternatives, transportation usage of energy, actions needed to develop alternate energy sources, and major findings and conclusions.

22. The National Energy Plan, Executive Office of the President, Energy Policy and Planning, Washington, DC 20500, April 1977.

- The plan examines the national energy problem, describes the national strategies on energy including conservation, improved energy efficiency, development of alternate and renewable resources; discusses the national goals, the role of government and public in achieving energy independence.

23. Navy Energy R&D Program Plan FY1979-FY1984, October 1978, Chief of Naval Material.

- The plan describes the energy situation that necessitates careful Navy planning for future energy supplies; the objectives and goals, program direction, and management of the Navy's energy R&D program; and specific energy R&D projects planned for FY1979 through FY1984.

24. U.S. Air Force Energy Plan 1978, July 1978, Chief of Staff USAF.

- The 1978 U.S. Air Force Energy Plan summarizes the Air Force energy situation and defines Air Force energy objectives. Current Air Force energy management, energy conservation, alternate fuels, and advanced energy technology programs are described and assessed. Management and program actions required to meet Air Force energy goals are recommended.

25. U.S. Army Facilities Energy Plan, 10 October 1978, Office of the Chief of Engineers.

- The plan provides policy and planning guidance to MACOMS for the development of detailed facility energy plans. The facility energy plans when staffed through the responsible MACOMS will collectively form the completed Army Facilities Energy Plan. It will show how MACOMS and Army facilities plan to achieve Army energy conservation goals while insuring a high state of readiness.

26. Five-Year Research & Development Plan, Functional Area: Energy and Energy Conservation, 15 January 1979, U.S. Army Construction Research Laboratory, Champaign, IL.

- The plan encompasses the development of systems and technology for energy conservation measures, the use of alternative energy systems, and the management and control of energy resources at Army installations. The objectives of the plan are to enable the Army to meet the 1985 DOD energy goals and to minimize the adverse impacts of rising energy costs and decreasing availability of petroleum-based fuel on the mission of the Army installations.

27. "Army Energy Plan-Draft," United States Army Energy Office, Washington, D.C., August 27, 1979. Supersedes draft dated February 24, 1978.

28. "Defense Energy Goals and Objectives," Defense Energy Policy Memorandum No. 78-2, March 1, 1978.

29. "DARCOM Energy Research and Development Plan," Energy Systems Project Office, U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, January 1979.

30. "National Energy Plan II," Executive Office of the President, Energy Policy and Planning, Washington, D.C., May 1979.

31. "Accelerated DOE/DOE Shale Oil Products Program," Memorandum from Deputy Secretary of Defense, July 25, 1979.

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33. "Department of Defense Technology Area Description on Energy Research, Development, Test and Evaluation," prepared by Dr. George Gamota, Office of Deputy Under Secretary of Defense for Research and Engineering (R&AT), September 6, 1979.

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35. STOG 80, Headquarters, Department of the Army, circa April 21, 1979.

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37. "Project Plan for Reliability Fleet Testing of Alcohol/Gasoline Blends," U.S. Department of Energy HCP/M2184-01 (Rev), part of the Alternate Fuels Utilization Program, March 30, 1979.

38. Army Policy Statement on Mobility Energy Research and Development, dated 22 December 1978.

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